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Phantom Classmates : A Case Study Of Talented Mathematics Students Learning Via Telematics

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**Phantom Classmates: A case study of talented mathematics students
learning via Telematics**

by

Leanne S Clarke

BSc (New England University, NSW), Grad Dip Ed (New England University, NSW)

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of

Master of Education

At the Faculty of Community Services, Education and Social Sciences,

Edith Cowan University

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Abstract

The main advantages and disadvantages of the Telematics environment for talented mathematics students were investigated through a case study. The case study considered the interaction of, and opinions of 11 Year 9 students and the teacher/researcher. Participants were from nine schools in regional Western Australia, and were withdrawn from face-to-face classes to attend mathematics transmissions. Qualitative data were collected through student interviews, an anonymous questionnaire, tape recording of lessons, and teacher field notes.

Students all agreed the main disadvantage occurred if timetabling for Telematics transmissions did not align with their local school class times for the same subject. The teacher perceived the main disadvantage was that during lessons, for various reasons, students chose not to contribute, making it difficult to gain responses from students and create productive class discussions. Many students felt intimidated to contribute during class discussions. Allowing time during lessons for social interaction and encouraging students to reply directly to each other's contributions led to many students feeling more at ease to talk during lessons.

The researcher perceived the greatest advantage of learning through Telematics was that with the small classes she was able to work more on an individual basis with students and to check that students understood individual concepts. Towards the end of the data collection period, some students were offering comments on other students' work and their thoughts on the material being developed, without prompting.

The research concluded that for a particular issue, student responses were often in opposition. Consequently although some students found one aspect of his/her learning environment a distinct advantage, others found this a disadvantage; and for others, the same issue was unimportant. As such, it is not possible to categorise most aspects of the Telematics learning environment as either an advantage or disadvantage. Therefore rather than the teacher concentrating on eliminating or utilising certain aspects of the Telematics environment, the teacher needs to consider what individual students perceive as advantages and disadvantages and cater for those individual needs.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

- 1. incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;
- 2. contain any material previously published or written by another person except where due reference is made in the text; or
- 3. contain any defamatory material.

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Signature

1.3.2001
.....

Date

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I would like to acknowledge the administration from eight State Government schools across Western Australia, without whose permission to carry out this research, it would not have been possible. In particular, I would like to extend my thanks to the 11 students who participated in this research. I am grateful to these students for giving their own time to be interviewed, for their support, encouragement and interest in my undertaking further education.

I also acknowledge my mum, whose insistence on the importance of education is the only reason I finished high school, let alone graduate from university; as well as Kyser, who kept me company all those hours, flowing into years, as I philosophised on life in general and in particular decided how important education was to me. I dedicate this thesis to you both.

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Chapter 1 Introduction

The researcher has taught mathematics to high school students in Western Australia (WA) for a number of years and at the time of writing this report, her classes consisted of both face-to-face and external students in rural WA. On first beginning to teach by Telematics, she received professional development on how to use the technological equipment. Although the Telematics teaching environment differed considerably from the face-to-face environment, professional development on how to teach in this environment as opposed to the face-to-face classroom was not offered. In addition, to being assigned to teach by Telematics, she was not offered training on or required to have any knowledge of the needs of distance education students. Thus, she, as other teachers was left to discover by trial and error the best ways to utilise the Telematics environment and 'make-do' with modifications to face-to-face methods. A situation the researcher found unsatisfactory, both in terms of ensuring that the teacher firstly, knew how best to provide for the needs of the student and secondly, in ensuring that the needs of the student were being met. She preferred not to 'make-do' and was interested in what she, as the teacher, could do to enable lessons by Telematics to satisfy the needs of distance education students as individuals. This would not merely find satisfactory methods of learning, but could also exploit the opportunities available in the Telematics learning environment.

Background

To provide a background to this research, the following outlines the provision of distance education in Western Australia, the Academic Talent Program (ATP) and the state government decision to provide country students access to ATP subjects. In addition this section outlines the progression of students through the Student Outcome Statements (SOS), a description of the technological environment and of a short pilot study conducted before this research, and the theoretical framework. Chapter 4 provides descriptions of the learning environments relevant to this study.

Distance Education

Western Australia covers over 2.5 million square kilometres (Fab Facts Dimensions, 2000). The population for Western Australia in 1998 was 1 831 399 of whom 500 244

people lived in regional areas (Western Australia: Population and Demographics, 1998). This population across such a large area indicates that distance education "... plays an important role in delivering effective teaching and learning programs to remote and rural students" (Oliver & Reeves, 1996, p. 45).

Distance education for primary and secondary school students began in Australia "... during World War I in response to requests from parents in the outback ..." (Moore & Kearsley, 1996, p. 216). Initially distance education used written material and the postal system (Simonson, 1997). The use of two-way radios for education began in Australia as early as 1929 with the creation of the School of the Air (Moore & Kearsley, 1996).

Australia is currently equal to America in providing an extensive range of communication media for distance education (Moore & Kearsley, 1996). Australia provides technology including Telematics, and video-conferencing, currently used throughout regional WA, and exceeds America in systematically organising the technological resources utilised for distance education (Moore & Kearsley, 1996). "The infrastructure for Telematics is currently available in 140 isolated or remote schools in Western Australia and growing steadily ..." (EDWA, 1996, on-line). ATP mathematics can currently be studied through distance education in Western Australia via Telematics, audiovisual (AV) or WebCT (G. Gardner, personal communication, February 3, 2000).

The possibility that these other mediums of communication, specifically AV or WebCT, may constitute a different learning environment resulted in Telematics being the only medium considered in this research.

A Special Program Providing Equity for Rural Students

A report on "Schooling in Rural Western Australia" (Tomlinson, 1993) was prepared for the Minister of Education in 1993 in response to concerns such as the following stated in the report:

...rural students perform in the TEE [Tertiary Entrance Examination] at a level below their metropolitan peers. ... most able pupils transfer to city schools for their secondary education... (p. 6).

The report also stated that rural students under-performed across all areas in the TEE (Tomlinson, 1993). The report cited a number of reasons for this, including inexperienced teachers in rural areas, less competition and support from peers, and less facilities and choice of subjects in comparison to metropolitan schools.

Teaching by Telematics was first trialed to enable the educational needs of students to be catered for in their own school (Villanova, 1993). The Education Department of Western Australia (EDWA) (EDWA, 1999a) comments the provision of ATP subjects by Telematics is to ensure "... all students in government schools are provided with the opportunity to access education programs consistent with their needs and talents" (on-line). Providing ATP subjects is important to ensure talented students are "... achieving to their full potential" (EDWA, 1996, on-line).

The program is an EDWA initiative providing equitable opportunities for talented students in distant and remote areas. The ATP subjects are available to Lower Secondary students, the subjects include mathematics, science and the humanities (EDWA, 1999a). For face-to-face classes in WA there are six schools offering humanities and five mathematics and science, one school offering all four subjects (EDWA, 1996). EDWA states that these schools:

... organise programs of study which match students' abilities, interests, academic strengths and rate of learning. In addition, they provide strong pastoral care programs. These schools provide a learning environment, which is intellectually stimulating and rigorous. Students will be expected to work hard to improve their understanding and to achieve high skill levels. Telecommunications will be used to deliver some ATP courses to rural and isolated students (EDWA, 1996, on-line).

To enter this program students must undertake a selection process in Year 7 (EDWA, 1999a), Year 7 being the final year of primary school in WA. The percentage of students selected to study ATP subjects is traditionally less than five percent of the student population, although larger numbers, up to 15 percent may be accepted (EDWA, 1996). All participants in this research were studying ATP mathematics.

Student Outcome Statements (SOS)

Students studying ATP subjects at the researcher’s school have been assessed using SOS since 1996. SOS assesses students over a number of Levels of demonstrated ability, across the six Strands: Algebra, Chance and Data, Measurement, Number, Space, and Working Mathematically (EDWA, 1999b). Table 1 compares the expected progression of students of lower, average, above average and ATP levels of ability.

Table 1: Comparison of progression through SOS of mathematics students of differing ability.

Pathway	Strand	Year 8	Year 9	Year 10
ATP	Algebra	Level 5/6	Level 6/7	Level 7
	Chance & Data	5/6	6/7	7
	Measurement	5/6	6/7	7
	Number	5/6	6/7	7
	Space	5/6	6/7	7
	Working Mathematically	5	6	6/7
Above Average Ability	Algebra	Level 5/6	Level 6	Level 6/7
	Chance & Data	5	6	6/7
	Measurement	5	6	6/7
	Number	5	6	6/7
	Space	5	6	6/7
	Working Mathematically	4/5	6	6
Average Ability	Algebra	Level 5	Level 6	Level 6
	Chance & Data	4	5	5/6
	Measurement	4	5	5/6
	Number	4	5	5/6
	Space	4	5	5/6
	Working Mathematically	3/4	4/5	5
Low Ability	Chance & Data	Level 2/3	Level 3	Level 3/4
	Measurement	2/3	3	3/4
	Number	2/3	3	3/4
	Space	2/3	3	3/4
	Working Mathematically	2	3	3

The Head of Department of mathematics at the researcher’s school provides the information given at Table 1 as the guideline for expected progression of students through the Years 8 to 10 by SOS. Demonstrations of ability begin at Level 1 where a young child might demonstrate his or her ability at the most basic mathematics. The highest level is Level 8 (EDWA, 1999b).

Technological Environment

Each school has allocated an area of their school, such as a corner of the library, or a converted storage room, which is set up for the Telematics workstation. Each workstation needs a Macintosh computer, modem, headphone or speaker, microphone, two telephone lines (one for voice and one for the modem) and a telephone or dial-pad to dial for voice connection. Some schools are fitted with a satellite dish, which Figure 1 (Clarke, 1999) shows.

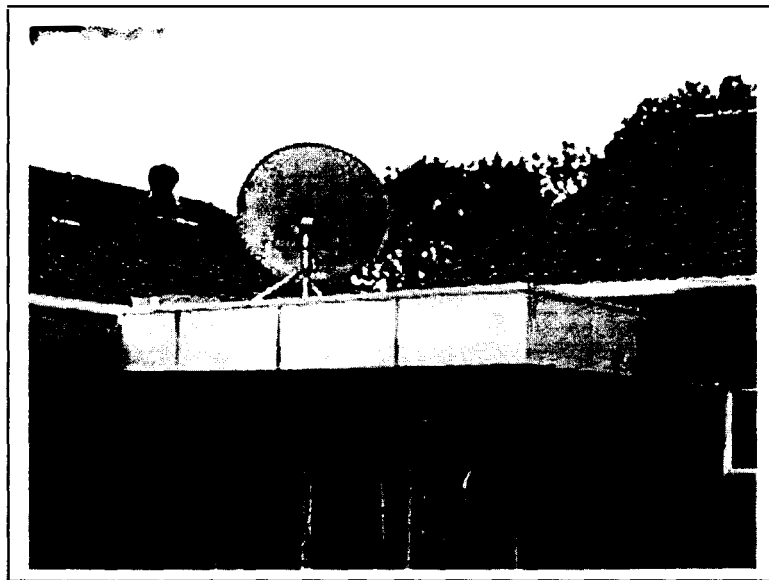


Figure 1: Satellite dish installed on school roof.



Figure 2: Example of Telematics students working at their Telematics Workstation.

Figure 2 gives an example of some Year 8 students at their Telematics workstation (Clarke, 1999). The students shown are not students involved in this research.

The voice connection is possible through a conference connection provided through Telstra. The students and teacher have an '1800' telephone number to dial. As each participant's voice-line connects, a 'beep' is heard, or if she/he hangs up or for any reason is disconnected. There are a number of methods used to listen to class members. Some had a headset, which included a microphone. A 'duct' was needed where there was more than one student, as this allows up to six individual headsets to be plugged-in, and students speak into the microphone attached to their headsets. Another method involves microphones that sit on the desk and the student must lean towards the microphone when talking, while a speaker allows the participant/s to hear other speakers.

For a transmission, the teacher connects to three schools simultaneously. From experience connecting more than three schools, resulted in unreliability of the modem connections. This unreliability has resulted in much higher rates of modem problems, such as disconnection. The number of students at each of the three schools would determine the numbers of students in a Telematics class.

Electronic Classroom (Electronic Classroom, 1994) is the software package utilised for transmissions during this study. *Electronic Classroom* allows class members to communicate via an interactive computer screen. The teacher has three modems connected through a 'scuzzy', which essentially acts as a mini-server. Each of the students' computers is connected through this mini-server. To dial another modem, a student's modem can dial the teacher's, or the teacher's modem can dial the student's modem. The student enters *Electronic Classroom*, in which a pull-down menu provides the option to dial another modem. Connections of modems during this study were at speeds between 2400 and 14400-baud rate. All class members have a series of bullets on their tool bar that indicates other schools to which they are connected. Figure 3 gives a diagrammatic representation of linking students and teacher in a Telematics lesson.

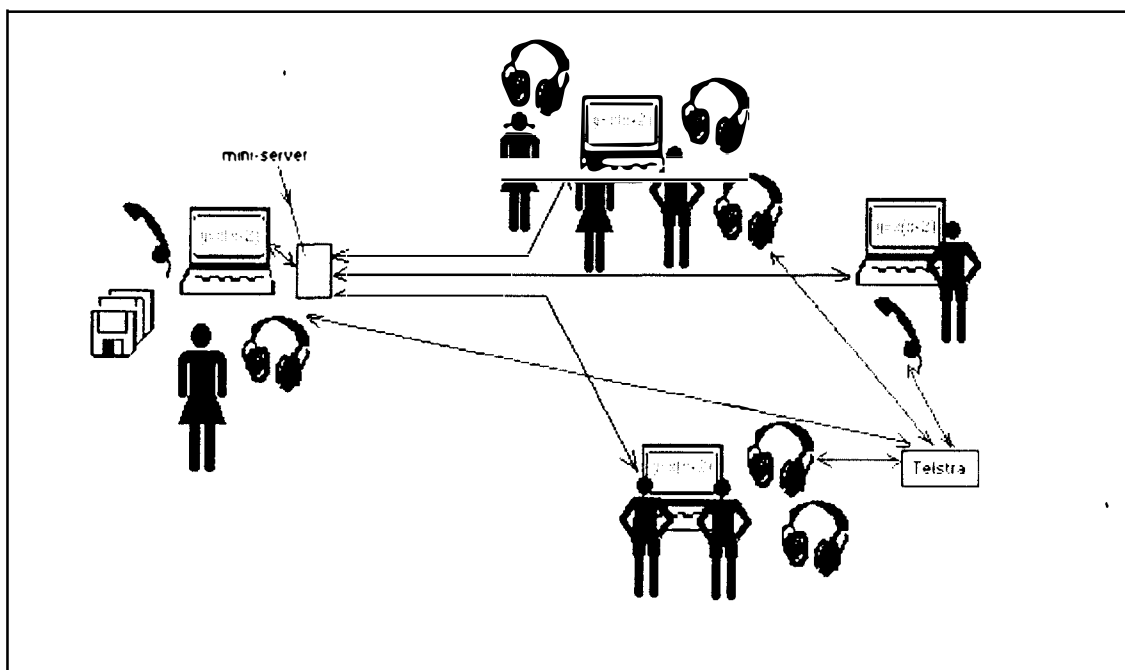


Figure 3: Diagrammatic representation of linking students and teacher in a Telematics lesson.

The teacher or a student can write on the screen and all connected computers will display the same material. The teacher can open pre-made files for the lesson and transmit these down the line. Depending on the amount of data in one file, transmitting a file can take up to a few minutes. *Electronic Classroom* provides an option called 'track-mouse', which allows all other connected computers to view the arrow shaped cursor as the controller moves it. Track-mouse allows students to indicate parts of the screen they are referring to in a spoken explanation.

A computer 'crashing' is the term used during transmissions when an error in the operation of the computer occurs, the computer must be re-started, and files re-transmitted before the lesson can continue with use of the computers. If a computer crashes, the lesson is only voice-oriented until the student/s have re-connected to the lesson, and this can take from a few minutes to over 10 minutes. A common cause of a computer crashing is that too many pages are open at once. Between one and three pages can usually be safely opened at any one time.

Forward and back arrows on the tool bar allow easy switching between open pages. 'Control' to write on the screen is possible by one site at a time. For a student to gain control she/he must ask the teacher to give him/her control. The teacher can gain control simply by pressing a bullet on the tool bar. There is the facility for free-hand

writing using the mouse, or simply by clicking the 'text box' on the tool bar will insert a text box for typing. The tool bar also provides easier access to drawing tools such as rectangles, circular shapes and line-width. Pull-down menus allow various other options such as changing colour, and creating new colours or font type etcetera. Figure 4 represents the basic screen, showing a file open.

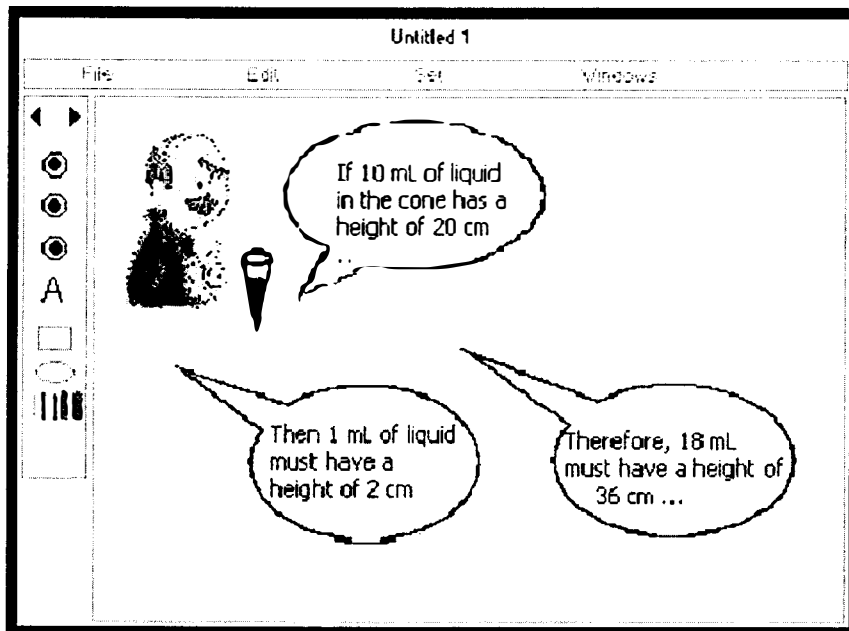


Figure 4: The basic Telematics screen with an open file.

Pilot Study

A short pilot study was conducted at the end of Term 4, in the year before this research. The teacher conducted the pilot study for three weeks with the students in her mathematics classes that she taught by Telematics at the time. Of the students involved in the pilot study five were participants in this research. Three other students were also involved in the pilot study.

The pilot study came about from two incentives. The first was, to consider better ways to utilise the Telematics lesson time. That is, time during most lessons, was used learning new material with little or no time remaining for discussion of concepts. Secondly, the teacher wanted to trial the intended research in order to consider if any further aspects of the proposed research could be refined or reconsidered.

The pilot study involved students being set activities to attempt, or readings and exercises to complete before a lesson. Work set to be completed prior to a lesson was carefully chosen by the teacher who ensured the activities set were such that students could complete them with little difficulty. The intention was that the activities would provide students with some introduction to the topic, thereby allowing the ensuing lesson to bypass the 'basics' of a topic. The subsequent plan was that during the lesson the time could be used to discuss what students had learnt, and to develop these concepts into discussions on the more involved concepts. There was also the intent that the class could discuss what students had understood about the material and allow time to discuss any further ideas the students had developed.

In general, the students who attempted the work did not find it difficult, were able to complete the set work, and were ready to discuss their ideas and further concepts. Where students did find work difficult, their queries often opened the lesson for further discussion. However, there was a considerable problem with the method, as only some students would complete the set work. It was therefore impossible to have discussions, as too few students knew enough about the material for the discussion to continue.

Those students who had completed the work would be frustrated that they had made this effort. Consequently, these students were to spend the transmission time working through the exact material she/he had worked through the night before by him/herself. Understandably, this situation left students disgruntled. Given these results, the teacher resolved to consider other methods of utilising the transmission time, as well as a different approach to the impending research.

Definition of Terms

Academic Talent Program (ATP)

The program is available to face-to-face students and to students in regional Western Australia through distance education to provide equitable opportunities for students (EDWA, 1996b).

Audiographics

Oliver and Reeves (1996) explain:

Audiographics involves two telecommunications links, one that connects computers via modems and a second link that provides an audio-conferencing medium through a normal telephone connection (p. 45).

Talented

EDWA defines 'talented' as:

... outstanding performance in one or more fields of human activity. Talent emerges from ability as a consequence of the student's learning experience (EDWA, 1996b, p. 5).

Telematics

Telematics is the term used in Australia for audiographics (Moore & Kearsley, 1996).

Transmission

For the purpose of this paper, a 'transmission' is when telephone lines connect the teacher and student/s for the distance education lesson.

The Problem

Encouraging students to be actively involved in their learning during a lesson and the teacher's aim of completing a detailed course within a condensed timeframe, are aspects of the ATP Telematics lesson, which may compete against each other. However, not only do these two aspects compete against each other, there are problems inherent in encouraging students to contribute actively to their lesson and in the method of teaching in the lesson. The following two sections outline these issues.

Teaching ATP Subjects by Telematics

ATP subjects, by nature, involve a detailed course. Face-to-face students have twice the time with their teacher and fellow students than do Telematics students - time that allows for group work and concentration on difficult material. Abercombie and Terry (1978) describe that given such time restraints the method of 'teacher talks and

students listen' is used as it has the advantage of being the quickest method to cover a large quantity of material.

Clearly, use of passive learning is not in keeping with current educational theories. However as there is a lack of specialist training of Telematics teachers to adapt their face-to-face teaching methods to the Telematics environment (McLoughlin, Oliver, & Wood, 1997), teachers are unsure what methods of learning best suit this different learning environment. The Tomlinson (1993) report recommended that training be provided for teachers. The report also recommended that teachers should "... be selected on criteria which recognise their commitment to, and their suitability for, distance teaching" (Tomlinson, 1993, p. 67).

Teachers are faced with a number of problems in adapting to the different teaching environment in Telematics from face-to-face teaching (McLoughlin et al., 1997). Dillon (1994) discusses the following issues of adapting to new learning methods. He explains that the teacher may recognise the benefit of students interacting to learn but may experience problems in adapting to this method of learning. Teachers with little or no experience with group discussions may find it difficult to encourage students to offer their opinions and to speak directly with one another in the group. In addition, the teacher needs to take on a new role in the class and may not know what role to take. In turn the students may not be aware what their new role is, nor the new role of the teacher. Another problem, Dillon explains, is that the teacher may be reluctant to stop leading the class, or perhaps may begin with every intention of allowing student discussion, but at some point resumes the familiar role of 'teaching'.

Students Choose not to Communicate Orally

To gain an ideal distance education learning environment, it is asserted that:

... as distance educators, our aim is to provide our students with opportunities for communicating as good as those which can be enjoyed by [face-to-face students] (Collins & Bostock, 1993, p. 334) .

That is, the distance education teacher needs to provide students with opportunities for "... formal and informal communication between students ..." (Collins & Bostock, 1993, p. 334). In addition, there is a need to allow time for students to ask questions of

their teacher rather than simply using the lesson for the teacher to pass on information to students (Collins & Bostock).

Alvermann (1995) and Dillon (1994) share the opinion that ego and self-esteem are large issues in students choosing not to voice a contribution during a lesson. Academically talented students are accustomed to being 'right' and are not comfortable with risking a negative response or attitude from fellow students (Dillon, 1994). Dillon states that competitive people often feel it is important to succeed and to appear to succeed in front of their peers. Alvermann points out a student's inclination to speak up can be greatly influenced by gender and puberty. With the onset of puberty, the self-esteem of many girls declines significantly and with this their courage to speak up, as they might have before.

Alvermann (1995) describes the situation where a student contributes and other students criticise the point of view or interrupt the contribution. This results in the student viewing this as a bad experience and thus chooses not to contribute in the future. Harasim (1990) describes one such situation where if a student makes a contribution and rather than hearing encouragement or acknowledgment hears only silence in reply, there may be anxiety created in speaking up at a future time. Alvermann describes the considerable concern of students over the frequency that group discussions become arguments. A significant problem is that students often feel they have no place to speak in the classroom as the teacher is usually talking and in fact, most teachers talk too much (Alvermann, 1995; Oliver & McLoughlin, 1997).

Theoretical Framework

The importance of students working together to learn rather than working individually is discussed by Meadows (1993). Meadows asserts Vygotsky's theory stating "... more complex cognitive functioning will be possible in a dialogue between two individuals than is possible for those individuals alone ..." (Meadows, 1993, p. 236).

The theory of Vygotsky states the importance of students working together, verbalising their thought processes and talking themselves through a problem, outlining that this verbal sharing helps particularly with abstract thought processes (Meadows, 1993). Meadows, describes Vygotsky's idea that the teacher can assist students through demonstrating the types of dialogue that are useful for problem solving. Meadows

continued to explain that by the teacher verbalising his/her thoughts and guiding the students, they will develop better internal speech to solve problems. With continuing experience, the student will need less assistance from a teacher.

The task of the teacher is to guide students’ own internal thinking, and to encourage students “... to take an active role in the learning process” (McLoughlin & Oliver, 1998). Simultaneously, the teacher is providing the opportunity for students to communicate their internal thinking with each other, and to develop more complex thinking as a small group than the student could individually. The diagram at Figure 5 outlines the socio-cultural theory of learning through communicating, which is based on the learning theories of Vygotsky (McLoughlin & Oliver, 1998).

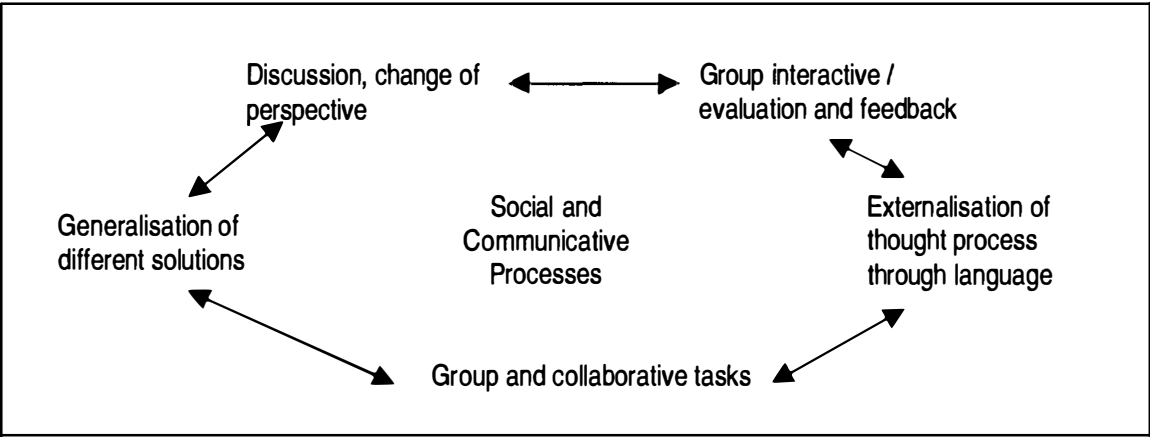


Figure 5: socio-cultural theory, based on Vygotsky’s communicative theory of learning (McLoughlin & Oliver, 1998).

However, as described in Chapter 2, students, for numerous reasons choose not to communicate in the Telematics lesson (Dillon, 1994; Alvermann, 1995). In addition, as outlined in Chapter 2, the Telematics learning environment differs from that of a regular face-to-face classroom (McLoughlin et al., 1997). A further issue is the different learning environment, in that Telematics teachers have not been trained to adapt their face-to-face teaching skills to the Telematics environment (McLoughlin et al., 1997). These three aspects of learning through Telematics inhibit the learning experience as outlined by McLoughlin and Oliver (1998) and Meadows (1993), which relies on the teacher to provide examples of his/her own internal thinking. Further, with students choosing not to communicate during the Telematics lesson, the practice of learning as a group through externalising thoughts (McLoughlin & Oliver, 1998) is hindered.

The model for learning in the Telematics environment could be modified from Figure 5 to include greater encouragement from the teacher for student communication during the lesson. In addition, for the teacher to improve his/her understanding of the difference between the Telematics environment and the regular face-to-face environment, it is necessary to undertake professional development. This professional development would encourage the development of and use of teaching methods suitable for the Telematics environment.

Figure 6 provides a suggestion for the socio-cultural learning theory, adapted to the Telematics environment. The adaptations being that prior to an emphasis on the teacher guiding student learning and learning occurring through student discussion, there is an emphasis on the teacher changing his/her teaching methods. In addition, there would be an emphasis on encouraging students to communicate their thoughts during the lesson.

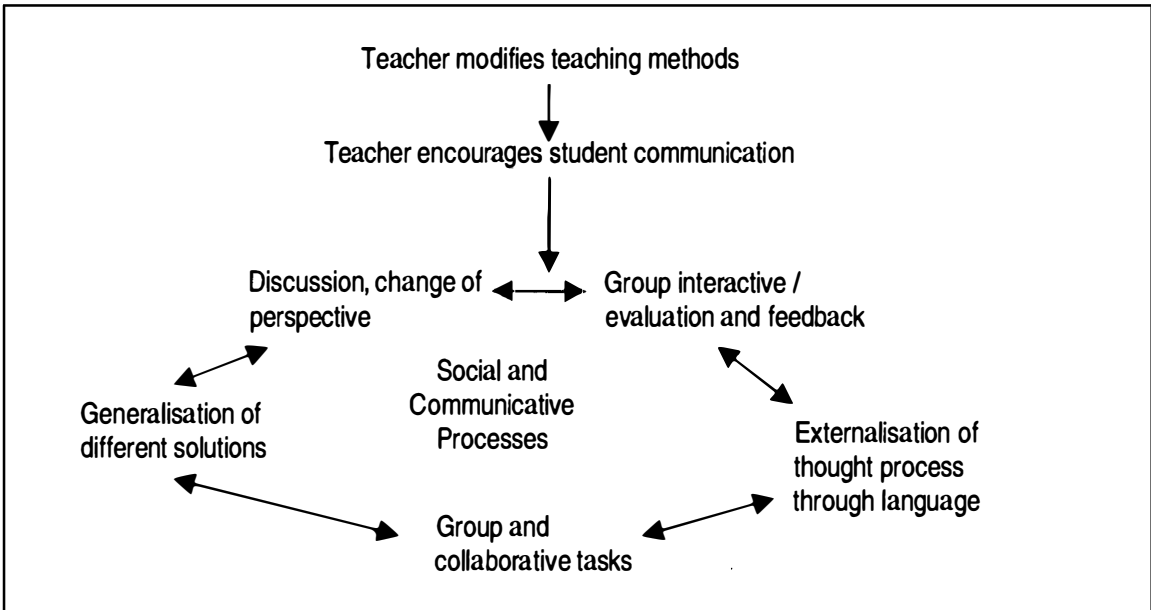


Figure 6: socio-cultural learning in the Telematics environment.

This framework forms the basis of the learning process for this study. The prime focus of learning beginning with the teacher altering her teaching methods utilised in the face-to-face classroom to methods better suited for the Telematics lesson. Following, and in conjunction with this change, the teacher encourages students to communicate socially and for mathematical discussions during transmissions. Once these changes have taken place a social environment is anticipated to develop an environment that will perpetuate itself. Through group interaction, students are encouraged to

externalise their own thought process, with this the group works collaboratively to complete tasks. Through class discussions and collaborative group work, students strive to elaborate on and analyse different solutions. In turn this encourages students to evaluate and provide 'feedback', inducing further group interaction and discussion of thought processes. Thus, at this stage, the learning environment of the class is moving in the perpetual circle shown in the framework.

Aim

The aim of this research is to consider what aspects of the Telematics environment are beneficial and what aspects are detrimental to learning for talented mathematics students. In doing this, the researcher aims to consider methods of decreasing or eliminating the negative aspects, and by identifying the positive aspects encourage their continued utilisation.

Research Question

What aspects of the Telematics learning environment are an advantage and/or disadvantage to talented mathematics students learning together as a small group?

Significance

Recently changes regarding teaching ATP students by distance education have been suggested, including an increase in the number of classes per teacher for the same teacher time (K. Murray, personal communication, December 8, 1999). There are, in addition, trials in place for decreasing transmission time, to be substituted by on-line, Internet instruction (J. Crystal, personal communication, August 20, 2000).

Past research has considered distance education in general (Findley & Findley, 1997; McLoughlin et al., 1997), also learning collaboratively, both in the face-to-face classroom and the Telematics classroom (Harasim, 1990; MacCallum, 1995; McDonald & Gibson, 1998). Considerable research has been conducted and theories developed regarding the education of gifted and talented students. Research on the perspective of talented mathematics students learning through Telematics has not been researched. This research is significant in that it not only considers the perspective of

these talented mathematics students, but it also provides insight into this learning environment for those making decisions regarding their learning. It is possible suggestions for changes (as previously mentioned) might become enforced changes that may erode the small number of advantages for students studying ATP subjects by Telematics. Awareness of the difficulties students face and the advantages these students currently have, need to be outlined to assist policy makers to act so as to erode the disadvantages, but not the benefits.

Chapter 2 Literature Review

This section considers the literature concerning learning in the Telematics environment and issues surrounding communication in the lesson. Incorporated are results from other research with current theories relevant to the Telematics learning environment and talented mathematics students.

Choice of Learning Environments

Students learning through Telematics have a different learning environment than in the face-to-face learning environment (Oliver & Reeves, 1996). Chapter 4 provides a description of the Telematics learning environment. Although some of the aspects of the Telematics environment compared to the face-to-face environment are limiting, others open opportunities "... that are not readily available in conventional classroom teaching" (Oliver & Reeves, 1996, p. 48). Considered below is the option of studying in the face-to-face or distance education environment. Also discussed are the technology issues inherent in learning through Telematics and the necessity of the roles of teacher and students to change in the new learning environment.

Simonson (1997), and Moore and Kearsley (1996) agree that although students enjoy their distance education studies, given the choice, they would not choose to study by distance education. Simonson found that despite the fact students do not prefer distance education to face-to-face classes "students are increasingly demanding to be allowed to learn at a distance" (Simonson, 1997, p. 105). Simonson (1997) states that "... there are many other considerations than personal preferences ..." influencing students' decisions (p. 105). Students value the social interaction that takes place before, after and during the regular face-to-face lesson, this interaction is a significant influence when considering the preference between face-to-face and distance education. Simonson describes this inter-personal interaction as an important aspect of the whole learning experience.

The Tomlinson (1993) report emphasised the significantly lower achievement of rural students in comparison to achievements by students from metropolitan areas. Although rural students have been found to achieve below metropolitan students, students studying by distance education have not been found to achieve any less than face-to-face students do (Simonson, 1997). Nevertheless, it is not known if distance students

“... study longer in order to assimilate course information ...” (Simonson, 1997, p. 106). Oliver and McLoughlin (1997) claim the reason face-to-face teaching has not shown itself superior to distance education, is that face-to-face classes use little teacher-student interaction.

Streamed Classes

The offering of this program does raise the controversial issue of streaming, and grouping students by ability. Presented below are a number of reasons favouring the grouping of talented students.

Yates and Chandler (1991) discuss the differences between academically inclined students and non-academically inclined students in applying knowledge to learn and understand new material. They also discuss the need for talented students to elaborate and generalise on material in order to gain better understanding of new material. Berger (1991) outlines a number of needs of gifted and talented students including problem-solving activities, and emphasises the importance of a differentiated curriculum for gifted and talented students. Davis and Rimm (1994) support the above ideas and state that gifted students need enrichment activities that expose “... students to a broadened range of knowledge in the particular subject area ...” (p. 151). Other activities need to include:

... creativity, problem solving, self-directed and independent study skills, research and reference skills and other thinking and affective skills, as well as skills related to the specific subject area (p. 151).

Davis and Rimm (1994) state that while many schools are eliminating streaming of classes, general grouping of students into academically talented students, average, and low ability students is beneficial. Such grouping is particularly beneficial where course programs are written for the given ability group and avoid giving a common curriculum across-the-form. Davis and Rimm (1994) state the following:

Students who are academically ... gifted should spend the majority of their school day with others of similar ability and interests ... such grouping ... has produced marked academic achievement gains as well as improved attitudes (p. 13).

Davis and Rimm (1994) do not encourage gifted and talented students learning in a group of mixed ability students. They comment that the only advantage of such groupings for the gifted and talented students would be social, not academic. That is, gifted and talented students benefit more from groups based on ability. Lando and Schneider (1997) also argue for streaming, having conducted a study into homogeneous and heterogeneous grouping of adolescents. They found there was better interaction and exchange of knowledge with the group of academically talented children.

Small Class Size

Hanushek (1999) asserts that reducing class sizes, a politically popular policy, is educationally damaging. Hanushek states that reducing class size is "... an expensive policy with little hope of improving overall student performance" (Hanushek, 1999, p. 44). Hanushek argues that in the past decades class sizes have been falling, but student performance has in general not been improving. Hanushek also argues that although research has shown there are "... some positive effects of [reducing] class size [there is] an almost equal number of negative effects ..." (Hanushek, 1999). The studies Hanushek refers to involve classes of over 14 students, whereas, Telematics class numbers are fewer than 14. Hanushek finds the costs involved with reducing class numbers, to be "very expensive" and "it could only make sense if there were no other uses for the money" (Hanushek, 1999, p. 44).

In contrast to Hanushek (1999), McRobbie (1997) stated the following.

... teachers report that they are covering more material faster, have fewer discipline problems, and have more time to give individual attention to students. Parents of those students say ... in smaller classes, their children are happier and learn more (p. 6).

However, McRobbie (1997) was unable to comment whether small class sizes improved student performance. Gursky (1998) does however quote studies that find improvement in student performance following reduced class sizes. The study Gursky comments on however, involves five-year-old children, rather than teenage students, which this research considers.

Self Motivation and Organisation

Rimm (1993) discusses the following issues that academically talented students consider when faced with the option of mainstream classes or talented courses. Academically talented students often find routine work monotonous and have a great desire for mental stimulation. Alternatively, students may be accustomed to putting in very little effort and receiving high results, and not find it agreeable to have to work in the talented program. Studying by Telematics means students have a different learning environment to adapt to, in particular students need higher motivation and greater study management skills than in the face-to-face classroom (Oliver & Reeves, 1996).

Local Environment and Support

The requirements for providing for the needs of talented students is summarised well by EDWA (1996a) in stating the following:

It is important that gifted and talented students' abilities be accepted, valued and fostered by teachers, parents, peers, and the community. Schools, parents and the students themselves need to consider the provision of learning experiences that broaden the students' knowledge and skills. For provision to be meaningful the following context is essential:

- A stimulating and interactive environment
- An acceptance of individual differences and potential
- A willingness to provide appropriate teaching methods...
- Flexibility of organisation (on-line).

Davis and Rimm (1994) discuss the external and personal expectations placed on students and the effects of these expectations on the students' performance, including the following. The expectations or lack of expectations of parents, teachers, other peers and the students themselves all influence the student's decision to succeed or not to succeed. Abbott-Chapman (1994) comments on the significant influence of family encouragement. In particular, Abbott-Chapman states that the value the family places on education greatly influences the attitude of the child towards such success.

Dillon (1994) states that competitive people often feel it is important to succeed and to appear to succeed in front of their peers. Dillon continues by stating that academically talented students are accustomed to being 'right' and are not comfortable with risking a negative response or attitude from fellow students. In addition, from past successes the student may have gained self esteem from performing at an above average level. Subsequently, the student may feel pressure to continue with this similar performance (Davis & Rimm, 1994).

Technology Equipment

The presence of technology does effect the learning environment, as there are clear differences in the face-to-face classroom compared to the computer-mediated classroom (McDonald & Gibson, 1998). This different learning environment influences social interaction and the dynamics of group interaction (McDonald & Gibson, 1998). Distance education by such media as Telematics allows interactivity in the lesson which is imperative, as students, like all people, thrive on words of encouragement, being addressed by name and in being given words of congratulations (Powers, 1997). Such interaction, Powers gives as the means for providing a learning environment in which students "... become immersed in the information" (p. 92).

Findley and Findley (1997) agree with Powers (1997) and state:

We must remember that technology could not take the place of educators. Technology has no sense of humor and no sensitivity to feelings such as frustration or happiness. Technology must be used with the human factor and not in place of it (p. 120).

Telematics teachers do however, require time to prepare material for lessons and to ensure a variety of teaching strategies is utilised (Findley & Findley, 1997). There are a number of advantages in preparing material before a transmission including sharing with other teachers such prepared lesson material (Collins & Bostock, 1993). One considerable problem with using technology for distance education is that software and resulting course-ware become out of date quickly and updates are costly (Yaverbaum & Kulkarni, 1997).

It is possible the need for taking extra steps to ensure an active learning environment are needed with a multi-media learning environment. It would be argued the multi-

media environment is "... a visually enriching environment that has the potential to achieve the highest rate of retention" (Yaverbaum & Kulkarni, p.140). An opposing argument being that it is merely "... a vehicle which by itself does not influence student achievement" (Yaverbaum & Kulkarni, p.140). In the multi-media classroom compared to the traditional classroom Yaverbaum and Kulkarni, quote one study that found no significant improvement in learning. Therefore, if the multi-media environment does not necessarily influence learning itself, then the environment needs to be better utilised (Yaverbaum & Kulkarni, 1997) for student learning. Subsequently the student must construct knowledge through cognitive activity and not by passive watching (Tynjala, 1997). Therefore in order to learn, students need to "... be doing something, not just watching ..." (Yaverbaum & Kulkarni, 1997, p. 141) as something is created by the multi-media.

The one significant advantage in using technology is that it allows students and teacher real-time interaction (Oliver & McLoughlin, 1997). Developments in the use of technology in distance education are derived from "... the implicit assumption that interactive environments are superior to others ..." (Oliver & McLoughlin, 1997, p. 10).

Some strategies for teachers are not possible in the Telematics environment. For example, Dillon (1994) suggests that:

Teacher questions do not stimulate student thinking and they do not encourage participation. ... The teacher can foster discussion processes by actively using non-questioning alternatives - statements, signals, silences ... (p. 78).

The introduction of technology, and more powerful technology, into distance education, however, does not assure that distance education will improve, or that the applications of the technology will emerge or be applied (Simonson, 1997). Simonson explains that changes do not happen merely because of technology; rather, people have to make changes happen. It is "... the content of the instruction, ... and the involvement of the learner in the instructional experience ..." (Simonson, 1997, p. 104) that influence learning. Yaverbaum and Kulkarni (1997) agree, stating that technology is a vehicle that in itself does not influence student achievement.

A problem with using technology is that technology problems can and do disrupt distance education classes, some of these problems are unavoidable, such as weather problems, although other technology problems are avoidable with regular maintenance (Findley & Findley, 1997).

Necessary Computer Skills

Collins and Bostock (1993) found that in conducting computer conferences it was "... necessary to provide all our students with the option of following a one-day intensive introduction to personal computers" (p. 335).

An Attempt to Dispel Isolation

The importance of communicating in the lesson by Telematics is aptly described as critical as "... it is through verbal interactions with a teacher and peers that students participate in learning at a distance" (McLoughlin et al., 1997, p. 10). Communicating as a means to dispel isolation and establish affinity and problems in establishing good communication in the class, is discussed in detail below.

Knowing others Personally

It is essential that students feel they are part of a group, feel they belong and have a bond with the other students in their class (Findley & Findley, 1997). A number of reasons for this are outlined below.

DeVries (1997) discusses Piaget's ideas of working cooperatively. DeVries relates that if students learn in an atmosphere where there are personal relationships, the students will feel obliged to establish or follow a set of classroom rules and to re-establish equilibrium should disagreements occur. In this sense students construct a collective set of values and cultivate a feeling of community (deVries, 1997).

Findley and Findley (1997) stress the importance of students communicating with each other via technological links to enable class members to be able "... to relate to each other on a personal basis" (Findley & Findley, 1997, p. 118). It is important that the teacher in planning for lessons allows time for social interaction (Oliver & McLoughlin, 1997).

Getting to know you out of Class

Findley and Findley (1997) imply the importance of students knowing each other, stating that throughout the year where distances are not too great between students, a number of meetings for class members should be arranged. Findley and Findley suggest arranging other activities for students to get to know each other, if distances are too great.

Student Contributions to Lessons

McDonald and Gibson (1998) found that at the start of their study period student social interaction accounted for three-quarters of all speech communication, which had significantly decreased to just fewer than one-half towards the end of the study. McDonald and Gibson concluded that interpersonal communication remained important, but 'getting-to-know-you' conversations became less important as students knew each other better. This study was however over a limited amount of time and the researchers acknowledged the time factor could have influenced their results.

For many reasons, students may choose not to voice a contribution to a lesson. Alvermann (1995) and Dillon (1994) both share the opinion that ego and self-esteem are significant issues with students choosing not to contribute during a lesson. As mentioned in the introduction, Alvermann also points out that gender and puberty can greatly influence a student's inclination to speak up. With the onset of puberty, the self-esteem of many girls declines significantly and with this their courage to speak up, as they might have before (Alvermann, 1995).

One significant reason why students do not contribute is that they often feel they have no place to speak in the lesson as the teacher is usually talking (Alvermann, 1995). In fact, most teachers talk too much (Oliver & McLoughlin, 1997).

The following outlines a number of situations that Alvermann (1995) uses to illustrate why a student may not choose to contribute. Fear of insinuation that their contribution was silly or wrong or gaining a sarcastic response from another member of the group may inhibit students choosing to contribute. Alternatively, a student may contribute and other students criticise the point of view or interrupt the student, who then considers this to be a bad experience and will most likely not choose to contribute in the future.

Harasim (1990) describes the importance of students receiving a response to their contribution from another member of the group. Students may feel ignored or their contribution was not important enough to reply to, consequently the student may not contribute next time. That is, Harasim states, if a student makes a contribution and rather than hearing encouragement or acknowledgment hears only silence in reply, there may be anxiety created in speaking up at a future time.

Alvermann (1995) described the considerable concern of students over the frequency with which group discussions become arguments. The research by McDonald and Gibson (1998), on the other hand, reported that there were no incidences of conflict.

Small Group Assignment

Peterson and Sellers (1992) conducted a case study of students working in small groups and found that when cooperative groups are being formed the learning styles of the students involved need to be considered. In one example, two students are working together, and the working relationship of the students described as amicable. However,

The social learner ... appeared to be more interested in socialising and the independent learner became very frustrated by having to assume responsibility for project completion (Peterson & Sellers, 1992, p. 3).

Learning through Dialogue

Learning through sharing one's own ideas with fellow class members is considered in the following. In particular is considered how this learning could be most effective in the mathematics lesson, how discussions can be most effective for mathematics learning and issues surrounding the teacher and students contributing to lessons and learning.

Method of Learning by Sharing

Oliver and Reeves (1996) found that in the Telematics classroom there is little communication among students and, in particular, student-initiated discourse was limited. Oliver and Reeves also found that there is similar use of questions in both the

face-to-face and Telematics learning environments. That is, the questions are often narrow with minimal requirements for learners to reflect on the material.

Forman et al. (1998), state that mathematics education must include students developing their ability to inform others and convince others of their mathematical thinking. As such, mathematics education must be a social, not individual, experience.

Forman et al. (1998) suggested a method of learning whereby the teacher begins the lesson by posing a problem. They describe the ensuing lesson as involving increased student discussion of ideas and less teacher explanation. Student discussion in this situation involves discussion of ideas, making convincing arguments and students reflecting on and clarifying their thinking (Forman et al., 1998).

Forman et al., (1998) describe a face-to-face classroom situation where the teacher asks students to use the overhead projector to explain their working or solution to a problem, class members are then invited to comment on this. They argue that this method is in line with current theories of mathematics education and that such practices resemble those of actual mathematicians.

Love and Tahta (1991) comment on the difference between rote learning and learning to understand. Merely performing operations mechanically or routinely is classified as rote learning, as is performing operations “... without proper understanding of, or reflection upon, the matter in question” (Love & Tahta, 1991, p. 267).

Yates and Chandler (1991) discuss problem-solving methods of learning, and describe how there are differences in strategies developed by low and high ability students to solve problems. Yates and Chandler discuss the differences between how academically inclined students and non-academically-inclined students apply knowledge to learn and understand new material. They also comment that in order for students to gain a better understanding of new material, the students need to elaborate on material and make generalisations from it.

Commenting on Another's Working

Forman et al. (1998), suggest that the teacher encourage students to provide responses to student questions. They also suggest that the teacher encourages students to question the working and thinking of a fellow student, in order for the responding student to develop skills in explaining his/her thoughts.

Class Discussions

In the face-to-face classroom, whole class discussions require many students to remain silent (Inagaki, Hatano, & Morita, 1998). In addition, it is possible that many discussions are “dominated by teachers or a few students” (Locatis & Weisberg, 1997, p. 102) and that the students who are not involved may fail to learn (Inagaki et al., 1998). Inagaki et al. also comment that although many students may remain silent in a whole class discussion, these students may be actively involved in their learning. For example, a student who remains silent may identify with another student whose contribution is similar to his/her own thoughts and the student does learn through these contributions (Inagaki et al., 1998). That is, if students can discuss concepts as a whole class, they will then assimilate the information individually (Inagaki et al., 1998). Nevertheless, what has been shared jointly may not be understood similarly by individuals (Inagaki et al., 1998).

A particularly influential difference in the face-to-face and Telematics environments, as stated in the introduction, is the considerable time restraint on lessons conducted by Telematics. These time restraints, as Abercombie and Terry (1978) stated, often lead to teachers using the method of ‘teacher talks and students listen’ as it is the quickest method to cover large quantities of material. With the limited time available for transmissions in Telematics, Abercombie and Terry assert that time for detailed discussions is possible, although limited.

Role of Teacher in Class Discussions

For distance education to be successful, distance education experiences need to be equal to those enjoyed by face-to-face students (Collins & Bostock, 1993). It is essential that the distance education teacher provides for the needs of distance education students (Simonson, 1997). It is questionable, however, if such equivalent experiences imply utilising equivalent teaching methods. That is, there is no assumption that “... the attributes of effective face-to-face teaching are the same as what constitutes effective ...” (Oliver & McLoughlin, 1997, p. 11) teaching in the distance education class.

Inagaki et al., (1998) suggest the role of the teacher in a discussion is to question the student on what she/he has contributed or ask the students to rephrase their ideas. The teacher could also pose what appears to be a counter-example to the student’s ideas or

ask the student to give further explanations. Inagaki et al., also suggest the teacher could prompt other students to "... elaborate on the original response or to criticize it" (Inagaki et al., 1998, p. 504). Whole class discussions involving the teacher avoid some issues where students work in small groups by themselves (Inagaki et al., 1998). For instance, students may miss connections between ideas; verge off onto a tangent or be considering an incorrect idea thus, the group's discussion time is unproductive (Inagaki et al., 1998).

McLoughlin et al. (1997) has found that as the distance education learning environment differs from that of face-to-face teaching, teachers are generally unsure what methods of learning best suit the different learning environment. Additionally, although training is needed, there is no training provided for teachers to learn to adapt their face-to-face teaching methods to benefit students in the Telematics environment (Findley & Findley, 1997; Oliver & McLoughlin, 1997). Oliver and McLoughlin concluded it is essential teachers modify their teaching methods to better suit the Telematics environment and to suit the talented students in the class. Teachers who intended to involve "higher levels of interactivity between and among the instructor and students ..." (Findley & Findley, 1997, p. 118) require much more preparation time.

McLoughlin et al. (1997) discuss how teachers need to change their teaching methods towards better suiting the Telematics environment and the talented students in their class. Pettersson (1995) perceives teachers as facilitators of learning rather than in a traditional teaching role. Dillon (1994) comments: "The teacher acts to help the students to discuss the question before them, and also to learn how to discuss in general ..." (p. 59).

EDWA (1996b) comment on the desired attributes of a teacher for gifted and talented students, which also provides some guideline for the desired role of the teacher in the lesson. EDWA states:

... when gifted and talented students are asked about their 'ideal' teacher they rarely indicate that they want an 'expert who knows everything about a subject'. Rather, they mention those who support and respect them, who are patient, flexible, and have a sense of humour ... (p. 9).

Oliver and McLoughlin (1997) found that different teachers used different teaching styles. However, the style of teaching was usually based on the teacher's own preferred style, rather than a range of styles catering for the learning styles of the students.

Dillon (1994) discusses the following regarding the role of the teacher in the distance education lesson. Whereas a teacher may recognise the benefit of students interacting to learn, the teacher may experience problems in adapting to this method of learning. In addition, teachers with little or no experience with group discussions may find it difficult to encourage students to offer their opinions and to speak with one another in the group. With the best intentions, the teacher may begin the lesson with the aim of allowing student discussion. However the teacher may be reluctant to stop leading the class, or for another reason simply resumes the familiar role of 'teaching' at some point in the lesson. In summary, the teacher needs to take on a new role in the class and may not know what is the new role he/she needs to take. In turn the students may not be aware what their new role is, nor that of the teacher. Oliver and McLoughlin (1997), agree with Dillon on the necessity to develop new teaching practices for distance education classes.

Prawat (1997) considers the role of the teacher, particularly when for a particular topic student knowledge is limited, "ill-formed or too off-centre" (Prawat, 1997, p. 21). In this situation, Prawat states it is the responsibility of the teacher to lead the discussion, continuing to point out that all suggestions do not need to come from the students.

Student and/or Teacher Contributing

Oliver and McLoughlin (1997) have found most methods of teaching in the distance education environment are instructor centred. Oliver and McLoughlin also found that where a teacher initiates any dialogue the dialogue is usually limited with little or no cognitive interactions. This limitation comes about, as student responses will usually be in direct response to the question without further explorations. However, Oliver and McLoughlin (1997) state "... cognitive interactions are possible and relatively easy to implement ..." with appropriate teacher assistance (p. 22). Although such cognitive interactions are very useful most "... instructors tend to use the interactive elements, more to create a supportive and stimulating learning environment than for instructional support" (Oliver & McLoughlin, 1997, p. 22).

Abercombie and Terry (1978) outline a situation where students ask questions to “clarify difficult issues”; the teacher then asks students questions to ensure understanding (p. 41). Abercombie and Terry state such uses of time are teacher directed lessons that provide little time for group discussions.

Student contributions to discussions are not guaranteed to be clearly explained, in addition their “... ideas may be weak, inaccurate, or even false” (Inagaki et al., 1998, p. 522). Student discussions may bring about suggestions that although they seem plausible are incorrect, in such situations other students could be misled (Inagaki et al., 1998). Inagaki et al., argue that in such situations students will sieve out the incorrect answers and “... focus on and incorporate plausible ideas only” (Inagaki et al., 1998, p. 523).

Forman et al. (1998), describe a situation where a teacher encourages student-to-student dialogue. The situation is a mathematics lesson where the teacher accepts a response from a student, the teacher, however, does not respond on the accuracy of the answer or the method or reasoning to reach the answer. Rather the teacher invites students to comment or ask questions of the student who contributed. Thus, Forman explains, the teacher encourages student-to-student dialogue and student accountability for their mathematical working.

Helpfulness of other Students

Meadows (1993), describes the theories of Vygotsky and emphasises the importance of students working together, verbalising their thought processes and talking themselves through a problem. This verbal sharing helps especially with abstract thought processes, in particular Meadows states that “... more complex cognitive functioning will be possible in a dialogue between two individuals than is possible for those individuals alone ...” (Meadows, 1993, p. 236). Vygotsky’s theory tells us that through verbalising thought and guidance from the teacher the students will develop better internal speech to solve problems, ultimately requiring less assistance from the teacher (Meadows, 1993). Oliver and McLoughlin (1997) confirm interactivity is essential in distance education for “... deep and meaningful learning to occur” (p. 10).

Summary

In summary, learning by dialogue through Telematics for talented mathematics students is outlined by current theories and past research to be influenced by numerous factors. Outside of the lesson is the local school environment and home environment; there are computer hardware problems and isolation from fellow classmates. The Telematics teacher has a number of factors influencing the design of the lesson to ensure student learning needs are catered for within the limited lesson time. In particular the teacher must ensure that methods of learning are suitable for talented students, that students are actively involved in their lessons, and that different learning styles are catered for in lessons. The teacher needs to consider his/her role in the new environment and assist students in adapting to their new role. The teacher needs to encourage and allow time for social interaction and building of rapport among students and between teacher and students. Lastly, although perhaps most importantly, the teacher must incorporate methods of learning that utilise verbal interaction to develop the mathematical content of the lesson.

Chapter 3 Methodology

The method of research is by case study, aiming to investigate the aspects of the learning environment that participants found to be an advantage and/or disadvantage to learning. The context of the case study was specifically Year 9 ATP mathematics students studying by Telematics in Western Australia. Although the study involved three classes, the case study was of individual students, rather than class groups.

The case study began in Term 3 1999 and continued for 16 weeks, ending mid-Term 4. Over the 16 weeks, a variety of qualitative data was collected, including opinions of participants on the learning environment, and how learning took place during lessons. Also noted were some parental comments and some local schoolteacher comments. This chapter will describe the participants in this research; the instruments used to collect the data; the procedure for collecting the data; and how the data were analysed.

Participants

The students asked to participate in the case study were current students in the researcher's mathematics Telematics classes. Students from classes other than the researcher's classes were not included in the study, as the researcher could not adequately validate the learning methods used in another class.

The Researcher

The researcher is a participant, in her role as the mathematics teacher. The researcher was at the time one of six mathematics teachers who taught mathematics for both face-to-face students and ATP distance education students. The researcher lived and taught in the suburbs of Perth. The local high school at which she taught catered for about 1200 students from Years 8 to 12.

The Students

The case study involved 11 students aged approximately 14 years. The participants were five female and six male students from eight state government schools across regional WA. Five of the students were the only student at their school studying ATP Year 9 mathematics, while the remaining six students were from three schools, with two students at each school. The research proposal planned for 13 participants, one of

whom withdrew from ATP mathematics immediately preceding the data collection period beginning. The other student continued to study ATP mathematics, but declined to participate in the research.

Pseudonyms were allocated to schools and students for anonymity. Students at a given school have a pseudonym beginning with the same letter as the school for easy reference. For simplicity, pseudonyms were assigned in groups corresponding with the actual classes; that is with words beginning with A, B, C, and J, K, L and S, T. The possibility that gender may be an issue led to allocating pseudonyms for students by keeping the gender of the student. For further anonymity, the term ‘high school’ was substituted for references to Senior High School or District High School. Table 2 shows the allocation of pseudonyms to students and schools with students grouped into their actual classes.

Table 2: Participant's pseudonyms, schools and classes.

Class	9-01	Class	9-02	Class	9-03
Andrew	Ayre High School	Jim	Junctionville High School	Sally	Salt High School
Bill	Bent High School	Jamee	Junctionville High School	Tomas	Tripville High School
Belinda	Bent High School	Kristine	Kwin High School	Tristan	Tripville High School
Christopher	Char High School	Leslie	Line High School		

The students each live in rural areas of Western Australia, between a few hundred and a few thousand kilometres from Perth. Some students live on the coast and others live hundreds of kilometres inland either on large properties or in rural towns.

The three classes in the study are not necessarily typical of the majority of ATP Telematics classes. The classes in the study have the unusual arrangement in that five of the eight schools have only one student enrolled in Year 9 Telematics mathematics and science. At the time of this research, the program was only in its third year of being offered and student numbers were low. These initial years of the program being offered had lower numbers of enrolments than subsequent years. Table 3 lists the number of talented students studying ATP mathematics by Telematics by Year group.

Table 3: The number of WA schools with talented students studying Mathematics by Telematics in 1999.

Number of students at individual school	Number of schools with this many students			Total
	Year 8	Year 9	Year 10	
1	10	10	2	22
2	8	2	1	11
3	4	1	0	5
4 or more	3	1	1	5

Program Entry

The participants were enrolled in ATP mathematics in Year 9 studying by Telematics. Jamee, Jim and Belinda studied only mathematics by Telematics; the remaining students also studied ATP science by Telematics. Ten of the participants were selected to study ATP mathematics from the testing completed in Year 7. Each of these ten participants successfully completed studying the mathematics Academic Talent Program in Year 8 through Telematics.

The eleventh student, Jim, did not gain a result above the cut-off in the Year 7 testing, and studied Year 8 mathematics in the mainstream classroom at his local school. By school recommendation, he entered the program in Year 9. Ironically, Jim has shown himself as one of the most talented of all the Year 9 ATP students. Jim has consistently demonstrated ability in Level 7 Outcomes, whereas other students such as Kristine and Tomas have not be able to consistently demonstrate ability in Level 6 Outcomes (refer to Table 1 for expected progress of ATP mathematics students). Therefore, despite entry into the program, it is questionable that all the students are in fact academically talented. A reason that not all students are talented was stated in Chapter 1, with up to 10 percent of students selected to study ATP subjects who may not be talented (EDWA, 1996a).

Examples of Ability and Organisation

The following competition information is presented to provide a better picture of the level of academic ability of the participants. In Year 9, Jim, Jamee and Tristan were presented with monetary prizes in the Australian Mathematics Competition (AMC). Three of the other research participants received distinctions and a few students were awarded a credit. In comparison, the face-to-face Year 9 ATP mathematics class of 34

students at the researcher's school gained no prizes in the AMC and few distinctions. In addition, in the Australian Schools Science Competition, Tristan gained a high distinction and in the Australian Schools Computer Competition, Bill received a high distinction.

Tristan is a student with special needs having been diagnosed with Asperger's Syndrome. This considerably affects his communication skills with his peers and in communicating his ideas during a lesson. During lessons, his interaction with other students is often lacking in subtleties or politeness. Tristan's inability to organise his own study was described by the Visiting Teacher as typical for students with Asperger's Syndrome.

A School Week

The participants each attend their local school, studying most subjects in the mainstream face-to-face classroom. The students are withdrawn from their regular classes to participate in their Telematics transmissions.

The high schools involved in this research timetable between three and four hours each week for mathematics. Two of these hours involve transmissions for mathematics; the other one or two hours are for students to complete assigned weekly work and any current assessments. To provide a comparison with a face-to-face class which meets for six forty-minute periods a week, the material covered in three of those periods needs to be covered in one one-hour transmission. All students are expected to post their weekly work to the Telematics teacher at the end of each week.

Transmitted lessons progressed with some similarity. Lessons began with greetings between students and teacher, connecting modems and discussing problems with homework or other issues regarding study. A number of pre-created files were used by the teacher to present concepts and examples for work to students. The majority of the class time is utilised by class discussion on the concepts and student attempts of examples. Chapter 4 provides a typical lesson in more detail.

Data Collection Instruments

Qualitative data were collected using the following instruments: field notes, a questionnaire and audio recording of lessons and of individual interviews. The following is a description of each of the instruments used for data collection.

Field Notes

The teacher kept a logbook for recording field notes. Field notes included records of incidents during Telematics lessons; student-student interaction; teacher-student interaction, and teacher thoughts on methods of learning. Outside the lesson, field notes recorded conversations between the teacher and a parent or the local school Telematics coordinator. Relevant conversations with the Visiting Teacher (for the area of Tripville for students with Asperger's Syndrome) were also noted. This variety of material collected ensures the field notes, were as Patton (1990) suggested:

... descriptions of what is being experienced and observed, quotations from the people observed, the observer's feelings and reactions to what is observed, and field-generated insights and interpretations (p. 242).

Notes relating to a transmission were often written after the lesson, as recording such notes distracted the teacher from the lesson. Although, care was taken to ensure notes were recorded as soon as possible following a lesson or conversation (Patton, 1990).

Questionnaire

The questionnaire was posted to students mid-Term 4. The questionnaire comprised both 'behaviour' and 'opinion' questions. These are described by Patton (1990) as follows:

Behaviour questions ask about what a person does or has done. These questions are aimed at descriptions of ... experiences, activities, actions by participants ... Opinion questions are aimed at finding out what people think about something, usually about various aspects of a program in which they have participated (p. 144).

The questionnaire contained two parts. The first part required students to rank from one to ten their opinion on a number of issues, included short answer questions, and ended with the opportunity to make any general comments. The second part of the questionnaire allowed students to give their opinion on certain issues, such as how the research was conducted. Numerical responses to the questionnaire were tabulated and written responses were encoded.

In particular the questionnaire allowed students to comment if they had felt intimidated during the interviews, and provided space for students to make further comments or state any problems they had with the research. The questionnaire is given in Appendix II.

Tape Recordings

Three lessons for each class were tape-recorded, and where possible tape recordings were made on the same or on consecutive days. Spoken communication was encoded to record interpersonal interaction, student willingness to be involved in discussions, indications of familiarity among and between students, in addition to indications that particular students felt intimidated or at ease to contribute during lessons. Events and progress in lessons that were not taped were recorded in the field notes. The tape recordings assisted in answering the research question, in particular to provide dialogue examples to illustrate different issues.

Two interviews were tape recorded for each participant. The interviews discussed a number of issues regarding learning by Telematics. The first interview took place in Week 3, the second in Week 8 of the data collection period. Interviews were tape-recorded, although only teacher notes are available for two recordings that were lost due to technical problems. The use of tape recordings of individual interviews is recommended by Patton (1982), particularly as the researcher can concentrate more on the interviewee's contributions, rather than having to interrupt the interview in order to ensure notes are accurately recorded.

Some questions were not asked of all students; for example, if the question involved a student who was the only ATP mathematics student in Year 9 at their school in the Telematics class. Additionally, a question relating to meeting other students would not have been asked if the student had never met his/her fellow students. It is important to note that this influenced the number of responses from students on some issues. That

is, there are between three and 11 responses to specific interview questions. The list of interview questions is given in Appendix I.

It was decided to include personal interviews as a method of collecting data as it provided the opportunity for participants and teacher to discuss the thoughts and experiences of the students. Patton (1982) describes the interview as "... a chance for a short period of time to try to get inside another person's world" (p. 182).

The data from the interviews was encoded and provided information on advantages and disadvantages of the Telematics environment and discourse during the lesson and as such were used to answer all aspects of the research question.

Data Collection Period

Immediately before the research period began, most students met at one of two social 'get-togethers'. As many participants meet immediately before the data collection period commenced and as this meeting influenced the findings of the research, it is therefore described briefly below. Also described is the subsequent process of the research over the 16-week period beginning with the start of Term 3.

Social 'get-togethers'

During the school holidays between Terms 2 and 3 two social 'get-togethers' were organised. The get-togethers had the sole purpose of students meeting socially with the opportunity to get to know each other better. Nine of the 11 participants attended a get-together.

The first get-together was attended by Class 9-03, with their siblings, parent/s, and their mathematics teacher. The teacher, who coincidentally taught the same students for science was invited but was unable to attend. The group travelled, in some instances over 200 kilometres to meet at Tripville.

The second get-together took place near Junctionville. Christopher, Belinda, Bill, Jim, Jamee and Leslie were invited along with their parent/s and sibling/s. Also invited was the student at Gibson who studied science but not mathematics by Telematics and who several of the students 'knew' at least by voice. Leslie declined from attending due to the distance. The science teachers of the above students were informed of the meeting but declined to attend. This get-together allowed three students from class 9-01 to meet

with each other, but unfortunately, the only students from class 9-02 who could attend were from the same school.

It was impossible for either Kristine or Andrew to travel the thousands of kilometres to meet with their fellow classmates. A number of parents from both get-togethers commented it did make a difference to how their son/daughter felt about their Telematics lessons. One parent implied she found that travelling over 200 kilometres outweighed the benefits of the get-together.

Students' opinions on meeting with other students at the two get-togethers were recorded during the individual interviews. In addition, Tomas wrote an article for the annual magazine about meeting his fellow students for the first time; and this article is given in Appendix III.

Collection of Data

The data collection period began at the start of Term 3 and continued for 16 weeks. The data collection began with the first recording of a lesson. The lessons that were recorded were conducted as usual and no particular topic was chosen for the particular lesson. For the third recorded lesson, the lesson was not so typical in that the emphasis was on a practical activity. For lessons not tape-recorded, field notes recorded student interaction taking place and the use of the time during the lesson.

Each participant was interviewed individually once at the beginning and again in the middle of the research period. During the interviews, students were questioned to clarify their opinions on different issues regarding learning by Telematics and interacting with other students in their class. Individual interviews were arranged to be conducted during a study period for each student. The second interviews took place early in Term 4. Students were posted the questionnaire in mid-Term 4. The questionnaire is given in Appendix II.

The use of student explanation and class discussion was emphasised increasingly during the research period. Simultaneously, the teacher aimed to contribute to lessons less and to encourage students to answer each other's queries and explain each other's errors.

Data Analysis

This section outlines the process of analysing the data, and measures to ensure validity and reliability of the findings of the research.

Data Analysis Process

The analyses of the data were an on-going process that began with the commencement of collecting the data. Tape recordings of interviews and lessons were transcribed, then encoded. Field notes and questionnaire responses were similarly encoded. A number of common themes began to become evident from sorting the encoded data. Table 4 lists the codes used to categorise the data.

Table 4: Codes used to categorise data.

Issue	Code
Learning: ATP course (course difficulty/streamed classes/speed of progress through)	LA
Learning: Commenting on another's work	LC
Learning: Discussions	LD
Learning: Joint assessment	LJ
Learning: Asking questions	LQ
Learning: Student-student Interaction during lessons, for mathematics	LSI
Learning: Student-student Interaction during lessons, for social interaction	LSS
Learning: Talking too much/too little	LT
Learning: Student-teacher Interaction during lessons	LTl
Students: Aloneness and/or autonomy	SA
Students: Contact out of lessons	SC
Students: Learning with people do not know	SD
Students: Knowing others	SK
Students: Local distractions or help	SL
Students: Social meetings/get togethers	SM
Students: Students at own or other school	SS
Telematics: Classroom verses Telematics	TC
Telematics: General/Miscellaneous	TM

Many of the codes began to emerge as common themes before the data analysis stage, that is, during the data collection period. All the codes, however, were formed due to the emergence of common themes in the data, as opposed to allowing any preconceived ideas for labelling data to dictate the grouping.

This method of coding data to enable grouping and analysis of the data had one particular consequence in that most data could be encoded under two or three codes. This was a strength as it allowed cross referencing and links between issues that may not have been otherwise realised. It was also a weakness, as the data to be analysed became a multi-dimensional maze.

Table 5 presents two examples of how the data were encoded. These two examples are from individual interviews with students; the examples illustrate how one response may warrant more than one code. Two codes were applied for each piece of data; firstly, the origin of the data (shown in Table 5 in both abbreviated and unabbreviated form), and secondly, the topic of the data (refer to Table 4 for meaning of codes).

Table 5: Examples of encoding data.

Data	Code for origin of data	Code for data topic
Teacher: What else do you think is good about learning by Telematics?	Be039P04	TC
Belinda: It's more interactive, and there's less people in the class, so the teacher can pay more attention to all of us instead of just the slower students. If you're stuck on something you don't have to wait for the teacher to finish with all the other students before they can answer your question.	(Belinda, 3 Sept, personal interview, section 4)	LTI LA
Teacher: What do you think about learning with people you don't see everyday?	To157P03	TC
Tomas: It's good, there's not really any need to do like Year 9 work, you just get put through however you are. It's easier to learn this way, you can go at your own pace, you don't have to slow down for people who don't know that much about Maths.	(Tomas, 15 July, personal interview, section 3)	LA

Once data were encoded, data with the same or similar topic were grouped together; to form collections of data based on common themes. This grouping allowed data from the field notes, questionnaire, interviews and tape-recorded lessons to be cross-referenced with each other to confirm findings.

Validity and Reliability

The internal reliability of the data were established in using a variety of methods of collecting data and using the method of triangulation in checking data (Patton, 1990). That is, the data were checked for consistency by "... comparing and cross-checking ... information derived at different times and by different means ..." (Patton, 1990, p. 467).

To ensure validity in interviews there was a tendency to structure the interviews according to the pre-determined list of questions. Although, the interview questions were not divided into the two distinct groups of 'Interview one questions' and 'Interview two questions'. This flexibility allowed interviews to progress in line with student responses, which was preferred to an imposed order of questioning. By including a degree of flexibility in the interview process, it is not believed the validity of the results have been adversely affected. In fact, Cohen and Manion (1994) noted the following:

... the main purpose of using an interview in research is that it is believed that in an interpersonal encounter people are more likely to disclose aspects of themselves, their thoughts, their feelings and values, than they would in less human situations. ... The more the interviewer becomes rational, calculating, and detached, the less likely the interview is to be perceived as a friendly transaction, and the more calculated the response also is likely to be ... (p. 282).

As the teacher was the researcher, there was a problem with the validity of student responses, in particular regarding interview questions concerning aspects of the learning environment, and teacher interaction with students during learning. The anonymous questionnaire was included to allow students to express any comments they may have felt inhibited to make during the interviews, and also to allow comments if they believed issues they felt were important had not been discussed.

Chapter 4 Results

This Chapter presents the data collected through teacher field notes, individual student interviews, anonymous questionnaire responses and tape recordings of lessons. The chapter is divided into two sections, firstly learning in the Telematics environment and secondly, issues concerning communicating in the Telematics lesson. Chapter 5 will consider what can be implied from the results, how the results compare to past research and to current theories of mathematics education.

A Choice of Learning Environments

This section considers student’s thoughts on and reactions to the Telematics environment. In particular, the attitude and effort of students; positive and negative influences on students; and issues with teaching methods in the Telematics environment have been considered. In addition, students’ thoughts on learning in a technology environment and the choice between face-to-face and learning at a distance are also considered.

When asked if students preferred the face-to-face classroom or Telematics they also clarified if they preferred mainstream or ATP. Table 6 presents student preferences, showing no students preferred to return to mainstream, although two students sometimes considered this option. The question of preference between learning by Telematics or in the face-to-face classroom divided the participants essentially in half.

Table 6: Number of students choosing Telematics or Face-to-face and ATP or mainstream.

	Telematics	50-50 (between Telematics and Face-to-Face)	Face-to-Face
ATP	4	0	5
50-50 (between ATP and mainstream)	0	1	1
Mainstream	0	0	0

The advantages and/or disadvantages of the learning environment created due to the streamed classes, small class size and learning at a distance are discussed in the following section.

Streamed Classes

The participants found numerous advantages of streamed classes. For instance, many participants found it advantageous to work in a situation where they have contact with students who have similar abilities and who understand their own thinking and ideas. One participant articulated this, stating that it was good to work with people "... who understand my contributions to lessons, rather than people who make other [snide] comments like in the classroom ...".

Students commented that in not having lower ability students in their mathematics class they could therefore work at an advanced level and faster pace suited to them. Participants preferred the benefit of studying in the talented program as they could progress at their own pace and did not have to "slow down" for people who "don't know that much about mathematics". Most participants felt their Telematics teacher had more time for them, rather than in the face-to-face class where the teacher gave more attention to slower learners. Comments such as, "it's much better to not have to wait for the teacher to finish with helping so many other students before answering my questions" were common. Tomas stated:

When we do normal mathematics and we get finished we just normally do more work; the teachers wouldn't bother about us. But in Telematics, since we are doing harder stuff we are doing what we are up to. Which is a lot better.

A number of parents commented they did not believe the work was too difficult for their child. Andrew's mother stated that Andrew needed the extension / the harder work. Most students preferred the level of difficulty of the talented course, and many found the work more interesting since it was more challenging. Participants did not make any comments that streamed classes were a disadvantage.

Small Class Size

Participants found the small class size an advantage, stating that discussions were more interactive and the ratio of fewer students per teacher allowed for teaching that was more personal with greater opportunity to ask questions. One student wrote:

It is ... good having relatively small classes because with too many people, it is not as easy to ask questions and make comments. But, there are still enough students to have different ideas on a topic.

Sally and Tomas both preferred the small classes, Sally stating that she liked the greater opportunity to ask her teacher questions.

Jamee identified what she thought could be a problem with small classes. She commented that if anyone had a “fall out with someone else, like a personality clash, it could be a big problem with such a small class”.

Self-Motivation and Organisation

The ability of participants to be self-motivated and organised in completing their weekly work varied from very good to very poor. Table 7 presents participants’ levels of study organisation and the Level of SOS in mathematics the students had generally demonstrated by the end of the data collection period. Participants are presented in alphabetical order. The level of organisation was determined by the records the teacher kept of weekly work submitted and homework and assignments completed on time; these are ranked as poor, fair, good or high. Levels marked by a dash (-) indicate the student was only just working in that Level by the end of the year, whereas Levels without a dash indicate the student had been generally working in that level throughout the year.

Table 7: Organisation and study habits compared to demonstrated SOS.

Name	And'w	Bel'a	Bill	Christ'r	Jim	Jamee	Kristine	Leslie	Sally	Tomas	Trist'n
Organise											
Study	Fair	High	Poor	Fair	High	Fair	Poor	Good	Good	Poor	Poor
Algebra	6	7-	6	6	7-	6	6	6	6	6-	6
C&D	6	6	6	6	6	6	5	6	6	6-	6-
Meas.	7-	7-	6-	7-	7-	6	6	7-	7-	6	6
Number	6	6	6	6	6	6	6-	6	6-	6-	6
Space	6-	6	6-	6	6	6	6	6	6	6	6-
W.M.	6-	6	6-	6	6	6-	5	5	6	6-	6-

Some students with excellent organisational skills found it an advantage to be able to organise him/herself and work at his/her own pace. Belinda in particular stated that she

would not like to return to either mainstream mathematics or to study mathematics in the classroom. She liked the system of “this is the work, these are your times to organise yourself, go at your own pace”. Belinda though, was one student who had developed excellent organisational skills, a skill many of the participants continued to struggle to gain. Leslie and Sally also had very good organisational skills.

A number of students found that being organised and motivated to do their work was the hardest thing about Telematics when they first started. A number of students, after two years of studying by Telematics, still had not developed the necessary organisational skills.

Students who had not developed good study skills, often spent many hours on homework, or alternatively, fell considerably behind in their homework. A couple of parents expressed some concerns at the hours their child was spending on homework, but through teacher-student and teacher-parent conversations better study habits were established with those students.

Bill commented he sometimes considered returning to the mainstream class, as the “work is less difficult”. Christopher found the difficulty with studying by Telematics came not with the level of difficulty of the course but the quantity of work and having to complete it by himself. Christopher felt he would probably find the course work much easier within the structure of the mainstream classroom, which would not require the high levels of self-organisation.

During Term 3 three participants were informed that they were behind and if they did not improve, risked removal from the program. Of these, two participants made efforts to improve significantly. A third student, however consistently provided reasons why work was not submitted, at times falsely claiming work was ‘in the mail’ to postpone ‘serious’ conversations on his progress and of his remaining in the program.

Local Environment and Local Support

Assistance with work between lessons from a family member or a teacher at local school was available to many students. Some participants had a teacher at their local school who was interested in the students’ progress and assisted them if needed, although most students preferred to “just work it out myself”.

Acceptance and encouragement of academic abilities by family and peers was available for some students. Certain students, who before studying by Telematics, had experienced negative comments from peers at their local school, seemed relieved to have found these peers to be considerably less critical now that they were not studying in the regular classroom.

For other students there was no support from their local environment. Some students had no assistance from family with organisation of study time or in completing work between lessons, even for some students who found organising him/herself difficult. Kristine's mother preferred to not "pressure" her daughter to complete her homework, especially as, she stated, this "causes a lot of arguments, and I didn't need to have any more arguments with my daughter". With some participants, there was the experience of arguments with parents about completing homework.

Many participants had the advantage of local support; which included parental assistance with organising study times and gentle reminders to complete homework. Such assistance helped some of the participants with their studies. In particular Jim's mother stated that she thought it vitally important to be well organised "and parents can help so much in this". Some parents were very strict about homework being up to date and checked this often; others knew their child was good at organising and left their child to organise him/herself.

Contacting their ATP teacher between lessons was not as easy for participants as contacting their face-to-face teachers. Not all students had a local teacher who was interested in their ATP studies, nor to help students with their work between lessons. Participants were encouraged to telephone, facsimile or use electronic mail (e-mail) to contact their ATP teacher to seek assistance; however, as stated previously, most students preferred to try to work it out themselves.

For some participants there were distractions in the background at the local school during transmissions. Some of these distractions significantly affected the students' willingness or ability to contribute and learn from lesson discussions. Some students described that their transmissions took place in the library at the same time as whole classes were in the library. These students commented that at times they could not even hear the Telematics discussion due to the background noise, one student was instructed not to talk aloud as she/he was disrupting a meeting happening in the room.

Another described a situation that resulted in him feeling very uncomfortable to contribute to the lesson. The situation was that his Telematics station was set up in the school library and other students were leaving the area of their mainstream class, coming over, and staring at him while he talked in the lesson. Other students reported they had other students coming past and looking in through the windows or walking in and out of the Telematics room. For some students other transmissions were a distraction, particularly if the other students used an open microphone rather than headphones.

Some students were subjected to family pressure to perform consistently at a high level. Kristine felt she had a number of expectations placed on her by her ATP teachers and her parents to succeed in her work and to be well organised. She commented that she was “sometimes frustrated and angry with Telematics”.

Several comments about pressure to perform were made unsolicited, in particular few students felt they had unrealistic expectations placed on them by parents or expectations contrary to their aspirations. One comment on the anonymous questionnaire clearly outlines the individual student’s expectations of the course and the influence of the student’s parents on the student’s attitude and effort with his/her studies:

... there are good things about it [Telematics] although I can’t really think of more good than bad. I learn more things, more often. ...

I guess when I first started I had bigger expectations than I do now. I always thought it would be fun, and more enjoyable, but now I’ve been doing it for two years it’s not that enjoyable, ...

The first year was voluntary but the second not; my parents pushed me to do it. They ... had very high expectations of me. So I wanted to show them I wasn’t all that good ... and started getting [Level] 5’s ...

There were no comments from students or parents stating they felt that placing students under pressure to perform was positive.

For some students having a partner at their own school was an advantage. A partner meant they had someone to work with, to help with understanding their work, and to help with computer and technology problems. One student commented on working with another student in the general comment section of the anonymous questionnaire; stating

I think it is really good having another Telematics student at your school. It's helpful in both understanding school-work and assessments.

In particular, Jamee found it was great to have someone else as "I can ask them questions if there is not a teacher around and it means I don't get lonely".

Participants commented a disadvantage of not having a Telematics partner at their local school was that they had no one to discuss their ideas with, consult with about homework or understanding of the material. Alternatively, those participants who did have, or, had in the past had a partner found there could be disadvantages in having a partner, as follows. With the small number of students studying an ATP subject by Telematics at one school there was little choice of who students worked with. Although most participants preferred not to be the only student at their school, for participants who had a partner at their local school there was the chance the students might have had a personality difference. The following comments from participants elaborate on this concept.

It would be worse than being alone if I did not get on with the other student; and

If the other person wasn't a friend it would not work so well as I wouldn't ask them questions and stuff.

Tomas, as his mother explained, disliked his partner to the extent he intended to travel to the next closest school for Year 10. Bill and Belinda stated they did not study together outside of transmissions due to personality differences, but neither had a problem with the other's presence, as in Tomas' situation.

Timetabling

Timetabling for transmissions was organised in the first week of the school year; the process began with timetables for students being sent to the researcher's school for ATP students studying mathematics and/or science. The timetabling process became an involved one, when taking into account the use of the Telematics equipment at each school for other subjects conducted by Telematics (e.g. the humanities and languages other than English). In addition, the face-to-face timetable for Telematics teachers and the use of the several work-stations at the researcher's school, limited times available for transmissions. At this time, every effort was set transmission times to match the mathematics times at the local school. Although this was complicated again, as students from three schools needed to be combined, to form one Telematics class.

A few students stated that they were "very lucky this year" as their Telematics transmissions occurred simultaneously with the local school Mathematics lessons, meaning the students did not miss local lessons in other subjects in order to attend Telematics transmissions.

Most students found the greatest disadvantage of studying by Telematics was the problem of having missed part or all of a local school lesson to attend the Telematics lessons. This was a problem for a number of reasons. Firstly, many students missed subjects they enjoyed, such as elective subjects. Secondly, the subject missed needed to be 'caught-up' later and thirdly, as students needed to leave other classes early or arrive late it was necessary to explain to teachers where they had been or where she/he were going. The last and possibly most important reason was that the student missed the actual explanations and discussions that had occurred during that lesson, possibly missing the opportunity to grasp important concepts.

Technological Equipment

The technology environment itself provided a number of advantages; in particular the students and teacher could visually display their mathematical ideas on the computer screen. Participants found using the computer screen to be particularly beneficial when making an explanation.

Participants had an 1800 telephone number and could join class discussions from their home telephone, as such students did not need to miss lessons if they were not at

school. Participants often rang in to the lesson from home if their local school had a no-student-day or the student was feeling too sick to attend school but well enough to be out of bed.

Students could communicate with each other and their teacher out of lessons by e-mail, to get to know each other better socially, or to discuss their mathematics. All students, except Tristan, communicated at least minimally by e-mail for either social communication or to work on the group assignment.

Participants found the disadvantage with the technology was that it did not allow visual contact between students. Christopher remarked that not being able to see others was a difficulty, as he could not see their facial expressions. One participant wrote:

I think Telematics lessons would be better if you saw the people you were talking to through video conferencing [AV]. That way they can tell whether you understand the question asked or not by looking at your face ...

The technological equipment had a main disadvantage in that it did not always work well; this problem is discussed in the following paragraph. Clarity of hearing students was a problem due to microphones not working properly, students forgetting to sit close to microphones and electric storms in any town between any one student location and the teacher's location causing static on the line. In particular Belinda found it "very annoying" when her contributions to a lesson were repeatedly unheard due to microphone problems or sometimes because her soft voice did not carry over the microphone. Other microphone problems derived from there being only one microphone between two students, meaning that during a lesson the students had to pass the handset between them to contribute, a practice Tomas described as a "hassle". These numerous microphone problems meant the teacher and students needed to speak with deliberate enunciation to be able to be heard.

A common technological problem was difficulty in connecting modems. Some lessons lost 10 to 20 minutes of lesson time trying to fix persistent problems with connecting modems.

Necessary Computer Skills

By the nature of Telematics, students needed certain computer skills; most participants without computer skills found themselves disadvantaged. Students needed to be able to perform some computer operations, in particular, to alter the baud rate for the modem speed, connect their modem to the teacher's modem, enter, exit and use the specific software and restarting a 'crashed' computer.

Participants ranged in their prior computer knowledge, one participant had assisted at his school with computer installation and maintenance, whereas some participants had needed basic mouse use explained on beginning study by Telematics. An advantage of studying through Telematics, for some students, was that they acquired new computer skills.

Some students found the use of e-mail between lessons a problem, particularly gaining access to e-mail facilities at school or home. It was interesting that for one student there claimed to have limited access to e-mail in order to discuss a joint mathematics assignment, although no such problems existed when using e-mail regularly for social interaction.

Not all participants were willing to learn how to use e-mail. When Tristan was asked why he had not learnt how to use e-mail, particularly as people were willing to help, he responded that he felt like an idiot to have to ask another student or a teacher for help.

Dialogue Examples

To provide an insight into the Telematics environment in which this research took place, this chapter provides two examples of dialogue; the first shows a typical lesson and the second a lesson with technological problems. These scenarios help to gain an insight into the learning environment, which is necessary, in order "to understand a particular action requires an understanding of the context within which it takes place..." (Campbell-Evans, 1992, p. 26).

All conversations, thoughts and actions presented in the scenarios are those either explicitly explained to the researcher during individual interviews, or are recorded conversations that took place during lessons. The problems described in the second scenario are those described by students as problems regularly faced. It is important to note that descriptions given during individual interviews are the only source of

information for the incidents and thoughts expressed for local environments. The reason for this being that, incidents occurring at a local school remained unknown to other students and the teacher, unless the student spoke of the incident. As an example, a student could have been sitting with his/her feet up on the desk playing Nintendo with the sound turned off. As the teacher and other students had no visual contact, unless what was occurring at the local school made a sound it remained completely unknown.

Dialogue Example - A Typical Lesson

Of the three classes involved in the research, the first scenario involves only Class 9-01 consisting of Belinda, Bill, Christopher and Andrew. The intention of this scenario is to give an insight into the thoughts of students, interactions between class members and actions taking place during a lesson and an insight into life for the individual student outside the lesson. The scenario also includes a detailed account of the events leading up to the Telematics lesson beginning.

The interaction between class members taking place during this scenario relies on the fact that the students and teacher have been speaking to each other for some months. Therefore participants are familiar with each other's voices and know by sound the person who was talking. If the example lesson had taken place earlier in the year, there is the probability that greater emphasis would have been placed on encouraging individual students to speak, and in identifying speakers. The dialogue and the introduction to the dialogue are in Appendix IV.

Comments on First Dialogue Example

The first example demonstrates the main differences between the Telematics lesson and the face-to-face lesson. A main difference being the considerably shorter time, that is, the four hours of lesson time available for face-to-face classes must be compacted into two hours of transmissions. These two hours are essentially shortened due to time for connecting and for loading new screens, although this time is used productively for social interaction and discussions regarding homework and progress with assessments.

A further difference from the face-to-face class is that Telematics students complete any written or exercise questions during their study periods, not during the Telematics lesson, whereas large portions of face-to-face classes would involve students working on problems. Time working through new material and discussing example questions

during the example lesson involve all students, the Telematics student required to be involved in the discussions, with direct feedback available for all students from the teacher.

Dialogue Example – A Lesson with Problems

This scenario highlighted a number of problems which, although not frequent, did occur during lessons. This scenario is from a lesson with Class 9-02 involving Kristine, Leslie, Jim and Jamee. Appendix V presents the dialogue example and an introduction to the dialogue.

Comments on Second Dialogue Example

The second example had a number of problems; most of these however were unavoidable. Students being absent from a lesson was a problem in that, as the class was small, with only a few students absent, half the class may miss important information, which is needed for subsequent lessons. Students arriving late to a lesson is a problem, as the lesson must essentially halt until that student is connected, and has been informed of what the lesson has consisted of until that point. A situation where more than one student arrives late, one after the other, may essentially 'waste' a large proportion of a lesson, with connecting and 'updating' each of the students in turn.

Problems with modems connecting were caused by many different reasons, ranging from plugs being knocked from the computer, electrical disturbances between where the student and teacher are located, or another student has changed the settings on the computer. Microphone problems can similarly be derived from various reasons, having microphone problems considerably limits the interaction between that site and other sites during a transmission. Electrical storms, although a seasonal problem, is one that cannot be ignored, and automatically prevents students at that school from participating in the lesson.

Summary

To summarise, the advantages and disadvantages in choosing the Telematics environment, rather than the mainstream rural classroom are outlined in the following. Streamed classes were held to be advantageous as the course was designed for student ability, the work was more challenging and students had greater attention from the teacher. The difficulty of the course for some however was a disadvantage in parts

when it was too difficult. Small class sizes were an advantage as students had more opportunity to ask questions during class-time, and class discussions were more interactive although it was perceived there to be a greater chance of personality differences. Many students found they had positive support and assistance in their study, including help with difficult work and in organising completion of work, from local teachers, peers and their parents. Other students however, had distracting background noise at school during their transmissions, had unrealistic pressure from their parents and possibly arguments with parents about organisation of study and completing work. The most considerable disadvantage arising if transmission times and local school timetables did not align. ATP mathematics by Telematics had the advantage of rural students achieving at Level 7 SOS, allowing well organised students the freedom to work at their own pace and at their own time. The same situation was a disadvantage for students with poor study habits who did not achieve higher Levels of SOS and struggled to keep-up with the set work.

The technological equipment provided the ability to visually display ideas on the screen, although not allow students to see each other, therefore not providing visuals of body language or facial expressions, which participants felt would be very advantageous. The technology had the disadvantage, in that it was unreliable. In particular, persistent problems with connecting modems and occasional problems with voice lines. Access to the 1800 telephone number was advantageous as students could attend lessons from outside the school. The availability of e-mail allowed communication outside of lessons, although some students were disadvantaged through lack of ease to such facilities, and other students were unwilling to learn how to use e-mail. Students with good computer skills were able to manipulate the computer quickly and easily. Students without such skills needed to learn them in order to carry out some computer maintenance and alterations to settings, which for some was considered an advantage and for others a disadvantage.

An Attempt to Dispel Isolation

Communication between students, both socially during lessons, and outside of lessons, was encouraged. Such communication was aimed to dispel feelings of isolation. Students taking part in 'getting-to-know-you' activities and having a local school partner were the aspects of study by Telematics raised as being helpful in students

feeling less isolated. Considered in the following are the advantages and problems associated with this attempt to dispel feelings of isolation. The following discusses these in more detail.

Knowing Others Personally

Many participants found that feeling isolated was one the hardest things to get used to when they first started studying by Telematics. Tristan rather elaborately described not knowing the other students analogous to talking to a machine and having “phantom classmates” and teacher. Belinda and Sally felt not knowing other classmates was impersonal, and felt as though they were talking to a “sound not a person”.

Due to the nature of distance education, participants did not have the same communication with other students as is available in a face-to-face classroom. Jim found it easier in the classroom as “there are people there and it is easier to talk with others [students]”. Kristine would prefer the face-to-face classroom, as there are other students and the teacher is right there, meaning she did not have to try to contact her teachers by facsimiles or telephone, et cetera. Tomas found that not having someone with whom to discuss work made studying harder.

Throughout the data collection period, the teacher encouraged social interaction during the times when screens were loading. The three boys, Christopher, Bill and Andrew chattered personally about movies, guns, and computer games during transmissions. In addition, the three boys interacted well in discussing the material / concepts and examples. Many students from the other classes interacted well during mathematical discussions.

Christopher thought it very important to know other people, as then he felt more comfortable to talk to them. At the time of the interview, Christopher did not feel intimidated giving contributions, although before he knew the others so well, he had felt intimidated. One student had studied by Telematics for some time without meeting any fellow classmates and commented “I got used to working with students I don’t know”. However, not all students were interested in knowing other students personally. For example, Sally stated “we’re here to learn maths, not socialise”.

Students’ opinions of each other were not always harmonious. Jamee found that it did help to know other students in the Telematics class, but “this is not the most important

thing". Jamee felt "it is more important to get along with other students, that students are polite etc to each other in class". Kristine, for instance, perceived that Jim liked to be "right" a lot, although she was the only participant, including the teacher, to say this.

Getting to Know You Out of Class

Participants remarked that there were advantages in meeting other students at camps and other places as this "helps to put a face to the voice, and helps to know what the person is like". Christopher thought it very important and made use of any opportunity to meet with others as he found it easier to talk in class if he knew to whom he was talking. Some participants had met other students a few times and felt that they knew these students much better from these meetings.

Many participants thought, however that meeting others out of class was not necessarily an advantage. Some students commented that meeting their fellow classmates was "fun" and "good" however it "only helped a bit". Tomas felt that he would not be comfortable telephoning another student and would find it easier to write e-mails. Sally telephoned a fellow student from another school one evening after school, however, Sally found the other student was far less organised than herself and was unable to help. She never tried again. Only a few students however, felt there was any real benefit in communicating socially outside of lessons. Andrew, Bill and Christopher regularly e-mailed each other between lessons, on a purely social level.

Tomas stated that "being isolated from everyone else is not good". The distances between participants hindered efforts to organise meetings between all students. Despite efforts to arrange meetings, one student commented that communicating with students from other schools was "a bit helpful in understanding work, [but] it is much more impractical and difficult to communicate with them".

Small Group Assignment

The only comment for the possible advantage of completing a small group assignment was given by Christopher. Christopher thought that over a longer period, joint assignments might be beneficial in building up teamwork skills over a distance. He considered it could help to get to know other students better if students worked on more assignments together.

Most participants found a number of disadvantages in completing the small group assignment. Participants agreed they needed considerable extra time if working with a student from another school on a project. For example, in order for one student to make a suggestion, the other to reply and make a suggestion etc it was necessary to exchange a number of facsimiles or e-mails. Participants compared this to an equivalent exchange in the face-to-face classroom, which would take a very short time. In addition, the exchange was more difficult as the ideas were usually mathematical and best described diagrammatically or algebraically. A further difficulty was that students could not always rely on other students to check for facsimiles or e-mails and that the other student would reply to their facsimile or e-mail.

Tomas stated he did not think working on an assignment with another student helped to get to know the other student better. All students commented that what communication they made to complete the small-group assignment contained no social interaction. All communication was regarding the assignment only. A final problem with group assignments was that two participants found they did get to know the other person better, and discovered they had personality differences, which in some circumstances could have carried over to the Telematics lesson.

Summary

To summarise, the advantages and disadvantages in attempts to dispel isolation are given in the following paragraphs. Students feeling isolated was a distinct disadvantage, as getting to know other students was not considered as easy as talking to people who were sitting in the same room. Not being familiar with their fellow classmates was found an advantage for some students who felt less intimidated to speak when she/he did not know the other students, whereas most students felt intimidated to speak if his/her classmates were not familiar to them. Allowing time for social interaction was beneficial for most students as this resulted in better interaction during class discussions. A few participants did not seem to need to interact socially in order to participate well during class discussions. 'Getting-to-know-you' activities were particularly helpful, in that most students then felt more comfortable talking during class; however, not all students were interested in getting to know other students. Meeting other students in person was considered advantageous as it "puts a face to the voice". Nevertheless, some students could not attend due to distances and

even for those students who did attend meeting others did not help more than a little in feeling comfortable to talk during lessons. In addition, not all students were interested in meeting with fellow students.

Students found it an advantage to have a local school partner, as this was someone to work with and discuss work with between classes. Although for some students having a local partner was a considerable disadvantage if there were personality differences. Not having a local school partner was felt to be a disadvantage as students found it was harder to study if there was no one to discuss work with. However, it was agreed among students that they would rather be alone than partnered with a student with whom she/he had a personality clash.

Learning through Dialogue

Students offered their opinions on learning through talking in the Telematics lesson. Students commented on the method of learning most commonly utilised in their mathematics lessons; that of attempting questions, then sharing working and ideas with others. Students also commented on how they felt about commenting on another student's work, what they thought of class discussions, and the role of the teacher in a discussion. In addition, students were asked to share their thoughts on whether the teacher or the student was the respondent to a question or comment; and lastly, students commented on how helpful they found other students in their class to be. These aspects of learning through dialogue are discussed in the following section.

Method of Learning by Sharing

The method of learning commonly used during the data collection period involved students each being given a question to complete, time to consider and then they were to present their process and solution to the class. Students had the opportunity to consider another students working or thinking processes in their own head, the aim of which was to reinforce understanding of the process. Appendix VI presents a typical scenario where the class is working, using the aforementioned method.

A number of students commented they much preferred this method than "just watching one person do all the work". A few students stated that it was good to be able to work through a question individually. Many students felt it was better that everyone was

working on their question at the same time rather than having to watch and wait as one person at a time worked through the question. Belinda pointed out that she found

[the lesson] gets boring when it is not done this way. As when someone else does them [examples] all, you know you could try it, but it would take longer, but you are not given the chance.

No student commented she/he found the method boring. In fact, no student had any point she/he disliked about the method. The only disadvantage students found with this methods was that it took much longer, but most felt the benefits were more important.

The teacher noted that students were willing to describe how they had completed a question, all they needed was the time, prompting and opportunity and many students provided their ideas. To encourage this situation, the teacher began, early in the data collection period, to prompt students to clarify their understanding of the mathematical process in a situation by asking such questions as:

Can you tell us why do you want [that] to happen?; and/or

Can you explain why would you want to do [that]?

Students began towards the end of the data collection period, with teacher encouragement and direction, to explain their own internal thinking for working through a mathematical problem. A number of students were fastidious about re-checking working and reasonableness of their solution, especially before presenting their working to the class.

Commenting on Another's Working

There were a number of advantages in participants commenting on a fellow student's work. Most students were open to discuss with fellow students the method she/he used to solve the problem and his/her solution to the problem. A few participants agreed that "it is good if another student point out my working is not correct as I can learn from it". Towards the second half of the data collection period, students began, with encouragement, to offer comments on a fellow student's work without prompting.

At the same time, many of these same aspects contained disadvantages, in particular many students continued to need to be prompted to comment on a fellow student's

work. Most students would not voice their thoughts unless they were sure what they were going to say was correct.

Class Discussions

Class discussions were found to have a number of advantages. Most students thought the best use of discussion in mathematics was to discuss different methods of solving mathematical problems. Although, some students commented they thought mathematics was more “right or wrong answers” and that “there are not as many topics in mathematics suitable to discussion, as in other subjects like science and English”.

Many participants found discussions good at the point where she/he knows how to do the work and get the answer, but does not know why. Belinda stated that in a discussion she may not understand the material and the “discussion is going on over my head, and then all of a sudden it just clicks”. She found “... this is when discussions are useful”. Christopher found it easier to ask questions during a class discussion than at other times in a lesson.

During the data collection period, the main application of discussions in the mathematics lesson was students discussing their methods of working through a problem. Andrew commented on considering another student’s methods of solving a problem to be good to “see what they do, and try to find if there are any faults in it or if it works”. Participants considered discussions better than “just listening to the teacher talk” or answering direct questions. Tristan compared discussion in Telematics to the face-to-face classroom “you do not have people trying to talk over you”.

There was however disadvantages to class discussions. For instance, participants commented that “too many discussions are boring”, and that it was not beneficial discussing concepts “I already understand”. In addition, participants commented that due to the learning environment there was the problem of not being able to see the other student’s facial expressions, therefore students could not tell how another student “was reacting to” a contribution.

Role of Teacher in Class Discussions

Sally commented she saw the role of the teacher in a student discussion, as someone to turn to when she was unsure about her own thinking.

The teacher made note of some aspects of the discussion she could help with. Firstly, on beginning a new topic the teacher could follow the thought processes and working of each student, and therefore correct mistakes or misunderstandings before they become habit. A practice she found herself not able to complete each lesson in the face-to-face classroom. Secondly, the teacher can insist on gaining sufficient responses to be satisfied that each student understood the concepts and could apply the understanding to a given situation. This practice was also one the teacher did not find herself able to accomplish in the face-to-face classroom.

Further, the teacher noted that she did influence student contribution to lessons. For instance, at the beginning of the data collection period, the teacher prompted participants to comment if a fellow student's comment or working was correct, the teacher noted that some students began to make such comments without prompting.

The sole disadvantage recorded regarding the role of the teacher in a discussion was in the difficulty the teacher found in changing her teaching patterns. In particular, the teacher often needed to remind herself to stop speaking and to encourage students to respond to a student's question or statement.

Student and/or Teacher Contributing

A number of participants remarked that an advantage of expecting students to comment on and consider the correctness of a fellow student's work was that the students "have to think more and make sure they understand the material themselves". Some participants stated they were happy to accept the response of a student rather than that of the teacher. The example presented below of a student responding to a fellow student's question is from the tape-recorded lessons and involves Leslie and Kristine. This lesson was introducing calculations with the tangent ratio. In the example, Leslie refers to a diagram with two sides of a deep chasm with a tree on one side, a marker directly opposite the tree and a second marker on the same side as the tree. The two markers and tree form a right triangle. The diagram Leslie references shows the distance from the tree to the second marker is 20 metres and a bearing has been taken from this marker to the first.

Kristine: Why would any one want to work out something using the tan rule?

Leslie: Well, say if you had to get across that chasm and you had chopped down a tree that was 14 metres instead of the 14.334 metres long you need! It will miss the other side and it will fall down instead of reach the other side.

A second example, of a student answering a student rather than the teacher being the respondent, follows. In this example, the class is considering methods of comparing data. The screen shows a simple table with rainfall recorded for 12 months for both Perth and Darwin. Tomas was asked to suggest what the data might tell us about the two towns. However, he is unsure where to start.

Tomas: Umm, I don't know! [pause]

Miss Clarke: OK, can anyone else help Tomas?

Sally: Well we can see Perth and Darwin are wetter at different times in the year, so we could graph it to show that better. [pause]

Miss Clarke: Yes, good. What else?

Sally: Well, if we found the two ranges and the means, we could see which city has the more consistent rainfall. [Continues ...]

Participants stated that if the teacher answers, in contrast to the student responding, they would usually accept the response or answer without question. However, if a student answers, participants remarked they would work through the response to check for accuracy.

There were also problems with the practice of students being respondents. Firstly, not all participants were pleased with the idea of students rather than the teacher responding to questions or comments. Jim, for instance, felt students "do not know as much and are not as qualified [as a teacher] to answer a question".

At the start of the data collection period, most participants felt the teacher, at least until that time, usually corrected mistakes and responded to comments. The teacher's notes reflected the difficulty she found in trying to change her teaching methods.

The most significant disadvantage with building a lesson around student contributions, was that many students were unwilling to contribute. Participants feared contributing to a lesson, in particular students feared being wrong, or that their "contribution is considered as silly", or that they might have gained a negative response from others. In addition, students feared that others were 'smarter' - a problem, as students did "not want to be judged wrongly". Outlined below are all participants' comments on why a student might not want to contribute:

I suppose I don't say as much because I'm not quite sure what they think and stuff. It's just the way I am, if I don't know everybody I talk differently than if I know them;

It was hard at first working with people I didn't know, it was like talking to a machine;

It was hard working with people before I knew them a bit better, because I didn't know what they are like or what they are good at;

[some students] may feel embarrassed if they gave the wrong answer;

... if someone is quiet, or not confident;

As everyone is just starting they might think that the other people are smarter. A shy student won't get involved as much;

... not knowing how other people will react, especially if you are wrong, or have views that differ from others;

Afraid of getting things wrong / getting teased;

If a student is unsure as to whether their answer to a question is right, or if they are naturally shy;

You don't want to give a wrong answer for fear of being judged wrongly; and

... some days someone will answer more questions than someone else will, but it is not the same people everyday. It depends more on the mood of the student at the time.

Kristine thought that not really knowing fellow classmates definitely influences the fact students don't interact much socially; and Christopher found that not knowing others stopped him from voicing his opinions, as he did not want to look like a fool. Leslie felt a bit uncertain at the start of the year, as he did not know anyone in his class. He felt a bit shaky talking to students until he knew them a bit better. Christopher and Jamee both found that before they knew the others better it was harder to talk, as they did not know how they would react to things and what they would think of his/her opinions. Sally felt that if she did not know the other students she was "less inclined to talk to them". One student felt a bit more comfortable talking with others "now I've met them - but not a lot more". Another student commented mood influenced whether he contributed to a lesson, and that sometimes he contributed a lot whereas at other times very seldom.

The following were offered as suggestions on how to stop students feeling inhibited to contribute to lessons:

Getting to know the people;

... realising that all suggestions aren't always bad ones;

Encouraged to chat together not on class work; like holidays and the weekend;

Just getting used to the people in your class, getting to know them better so that you feel more comfortable with them;

If the students knew each other better they would talk more and ask more questions;

Give them more of a chance to talk;

There should, but not excessively so to hinder learning, be idle chat so everyone should get to know each other better;

... would possibly speak more if know others more; and

Meeting them makes it better as know how they will react to things.

Bill felt that during lessons “there needs to be a bit of humour”. Participants felt that students who did not contribute to a lesson and left it to others to do all the work; or students who provide input all the time and did not allow others to contribute were equally “annoying”. Kristine said she would speak up and point out she does not like the person contributing all the time, but not if she “thinks the other student would just keeps talking anyway”. Christopher commented he also would have to ask someone “to be quiet if they were talking too much”. Bill explained that if one person was contributing all the time this could be annoying to another “person who wanted to contribute and could not get a word in”. Sally thought she did not know if Tomas and Tristan knew what was happening during lessons, as their input was limited and did not indicate they were following the discussion. She felt it would be better if all students gave input.

During the school Term before the data collection period, there had been a number of conversations regarding Bill’s consistent social chatter and ‘silly’ contributions to lessons. Another student’s parent rang to say he felt that Bill always talking was disadvantaging his child. The teacher and Bill’s father discussed with Bill appropriate behaviour in the lesson, with the threat of removal from the program. Over a period of a few weeks, Bill made a concerted effort to improve, and he said it was important to him to remain in the class.

Helpfulness of Other Students

The participants ranked the importance of other students for learning, in the face-to-face and Telematics lessons, and other Telematics students in the participants’ own school and Telematics students at other schools. Table 8 presents the results, with a tally mark for each response, and the nil column indicates those students who refrained from commenting or for whom the question was not relevant.

Table 8: Comparison of importance of students for learning, in the face-to-face and Telematics lessons, and in their own and other schools.

Lesson type	Other students	Level of Importance of Other Students (for understanding work and completing homework)										
		nil	low	2	3	4	5	6	7	8	9	high
Face-to-face	During class											
Telematics	During class											
Face-to-face	Out of class											
Telematics	Out of class											
Telematics	At own school											
Telematics	At another school											

In addition, students ranked the importance of students for completing assessments, in the face-to-face and Telematics lessons, and for Telematics students in own and at other schools. Table 9 presents these results, again, a tally marks each response, and the nil column indicates those students who refrained from commenting or for whom the question was not relevant. The conclusions gained from this information are discussed in Chapter 5.

Table 9: Comparison of importance of students for completing assessments, in the face-to-face and Telematics lessons and in their own and other schools.

Lesson type	Other students	Level of Importance of Other Students (for completing assessments)										
		nil	low	2	3	4	5	6	7	8	9	high
Face-to-face	During class											
Telematics	During class											
Face-to-face	Out of class											
Telematics	Out of class											
Telematics	At own school											
Telematics	At another school											

Summary

To summarise, the advantages and disadvantages of learning through dialogue are given in the following paragraphs. The method described as learning by sharing was found an advantage in that it was not monotonous, although it had the disadvantage of taking more time. The practice of students explaining their own thinking was advantageous as students learnt to express their own thinking, and through considering the thinking of others. However, there was a disadvantage as some students continued

to refrain from sharing their ideas unless specifically requested to contribute. Learning was assisted by fellow Telematics students during transmissions, although fellow students at other schools were not helpful between lessons.

Class discussions were found more interesting than just the teacher talking and these discussions helped students to understand concepts. Many students found it easier to ask questions during a discussion than at other times, and in the Telematics transmission found they had more opportunity to contribute than in the face-to-face classroom. Discussions were disadvantaged in the Telematics lesson however, as students could not see the facial expressions of those they were talking to. There was also the problem that too many discussions became monotonous.

Contributions by the teacher were considered to be advantageous when students were unsure in their own thinking or understanding, and to encourage students to participate, although the teacher's contributions became a disadvantage if the teacher talked too much. The practice that students respond to questions rather than the teacher was advantageous as students were then required to consider the material and ensure she/he understood it him/herself. In addition, if a student responded, students did not simply accept the answer, as she/he would if the teacher responded, but found it necessary to analyse the response for him/herself. Some participants were concerned that students were not as qualified to answer questions as the teacher was, and preferred to rely on the teacher to clarify or correct student responses as needed.

Summary of Results

For each aspect to be considered in learning through Telematics there are numerous advantages and disadvantages. In some situations it is possible to find solutions to the disadvantages, in others it is a matter of weighing up the disadvantages compared to the advantages and becoming accustomed to the situation. In many situations, students presented opposing perceptions, making it clear that the same situation was considered a disadvantage for some and an advantage for other students. The main disadvantage was clearly stated by all students to be timetabling problems and having to miss local subjects to attend Telematics lessons. The main advantage was stated by the teacher who was able to gain an indication of the knowledge of mathematical methods and understanding of mathematical concepts from individual students. A second notable

advantage came about through merely taking the time to ask students about their concerns and thoughts on learning in the Telematics environment. In doing this, the teacher was able to make suggestions to relieve some of the perceived problems or consider the benefit of some suggestions and include this in the lesson.

In summary, the following aspects of the Telematics environment were perceived by participants as having both advantages and disadvantages. Firstly, aspects regarding the Telematics environment are; contact with the Telematics teacher; learning through class discussions; the level of difficulty of the work; the home and local school environment; and working at his/her own pace and organising him/herself. Aspects of the technological environment are visual communication; access to the 1800-telephone number; use of e-mail; and the computer skills that are necessary. Aspects of being isolated are: the actual isolation; meeting other class members in person; taking part in 'getting-to-know-you' activities; social time during transmissions; and having or not having a local school partner. Finally, aspects of communicating to learn are: students not contributing; not knowing fellow class members; learning by sharing; explaining his/her own thinking; learning by class discussions; teacher and/or student as contributor to lessons; and learning with other Telematics students.

The only aspect of learning through Telematics that participants found to have no disadvantages was in having streamed classes.

Chapter 5 Discussion

This Chapter compares the findings of this research, as presented in Chapter 4 with past research findings and current education theories as discussed in Chapter 2. The findings are divided into sections matching those employed in Chapters 2 and 4.

A Choice of Learning Environments

The data in Table 6 is produced in graphical form in Figure 7. The preferences of students, between learning environments, shown in Figure 7 agree in part with Simonson (1997) who stated that students preferred not to study by distance education. However, nearly half of the participants stated they enjoyed studying by distance education, agreeing with the other statement by Simonson: that students wanted the access to the classes available by distance education. No participant preferred to return to mainstream, a result that may not have been found if a survey had been taken in Year 8 or earlier in Year 9, given the low retention rate of Telematics students. This research, however, did not investigate reasons students chose to withdraw from Telematics, and in particular if one reason for withdrawing was a preference for study in mainstream.

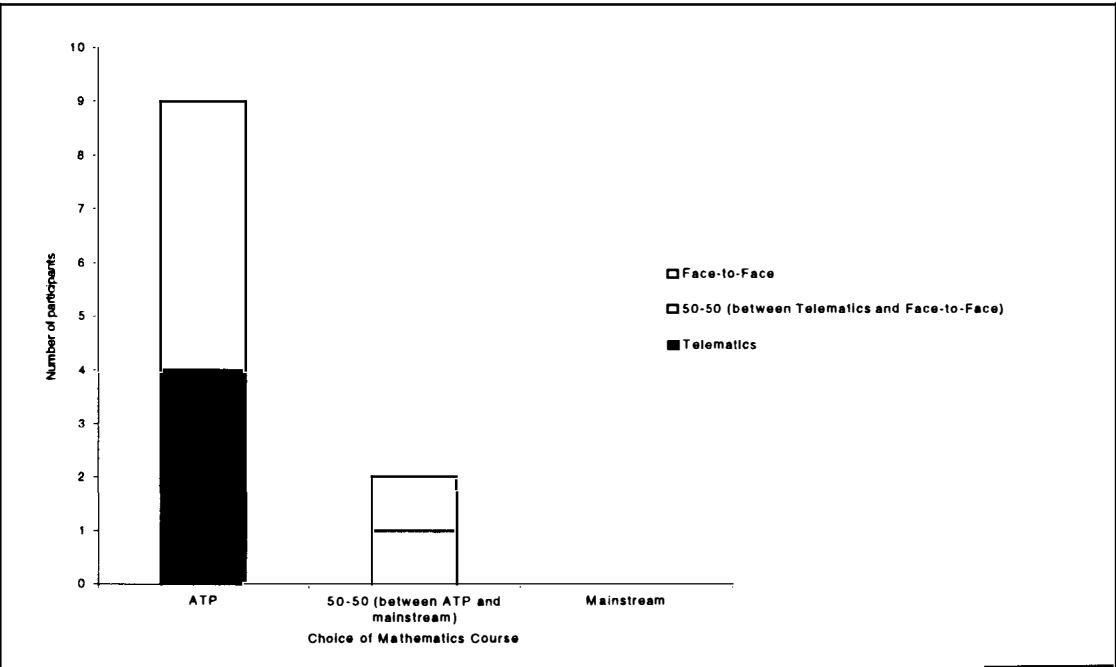


Figure 7: Student preference of ATP to mainstream and Telematics to face-to-face.

The variety of responses shown in Figure 7 are in agreement with Rimm (1993) who found that some students might prefer mainstream mathematics as it is easier, or they prefer ATP mathematics as it is stimulating. Approximately, half the students felt the course would be easier simply if it was in the classroom, rather than by distance education.

Streamed Classes

The following statement by Tomas, as given in Chapter 4, agrees with the findings of Berger (1991), and Lando and Schneider (1997) who state, talented students need to be separated from lower ability students and provided with a differentiated curriculum.

When we do normal mathematics and we get finished we just normally do more work; ... but in Telematics, since we are doing harder stuff we are doing what we are up to. Which is a lot better.

Similarly, the findings of Davis and Rimm (1994) stated that it is beneficial for talented students to be with other talented students and that talented students benefit from extra activities that broaden their knowledge.

It was also important to note that several participants perceived the Telematics teacher had more time for them, than did their mainstream class teacher when there were low ability students in the class. The issue regarding students receiving greater attention from their teacher is discussed further with respect to small class sizes.

Small Class Size

In agreement with the statements by Hanushek (1999), that student performance did not necessarily improve with small class numbers, at least four of the participants achieved Levels below those expected (Level 6). However, what those same students would have achieved in a larger ATP class or in the mainstream class at their local school is unknown. In contrast, the number of students who performed above the expected Level is in agreement with the findings of Gursky (1998), who found improved results with reduced class sizes. Although, again, whether the performance of these students was in fact improved or unchanged by the small class size, or if those students might have performed better or worse in a different situation was not investigated in this research.

Participants found that discussions were more interactive and they gained greater attention from their teacher. This is a finding in agreement with that of McRobbie (1997) who found that in smaller class sizes the teacher had more time for individual students.

Hanushek (1999) found a number of disadvantages, including monetary and performance with reduced class size however, comments on the benefits or otherwise of student interaction in smaller classes has not been found in other research. As such, comments as given by Jamee; who felt there could be problems with interaction in small groups; cannot be compared with other research findings.

Self-Motivation and Organisation

The data in Table 7, comparing the level of organisation of each participant, as compared to his or her average achievement in mathematics is summarised in graphical form in Figure 8. Figure 8 shows the number of Strands demonstrated in Levels 5, 6 or 7 by participants at the end of Year 9. The distinction made in Table 7, between those who had been working at a Level all year or only at the end of the year, is not made in Figure 8.

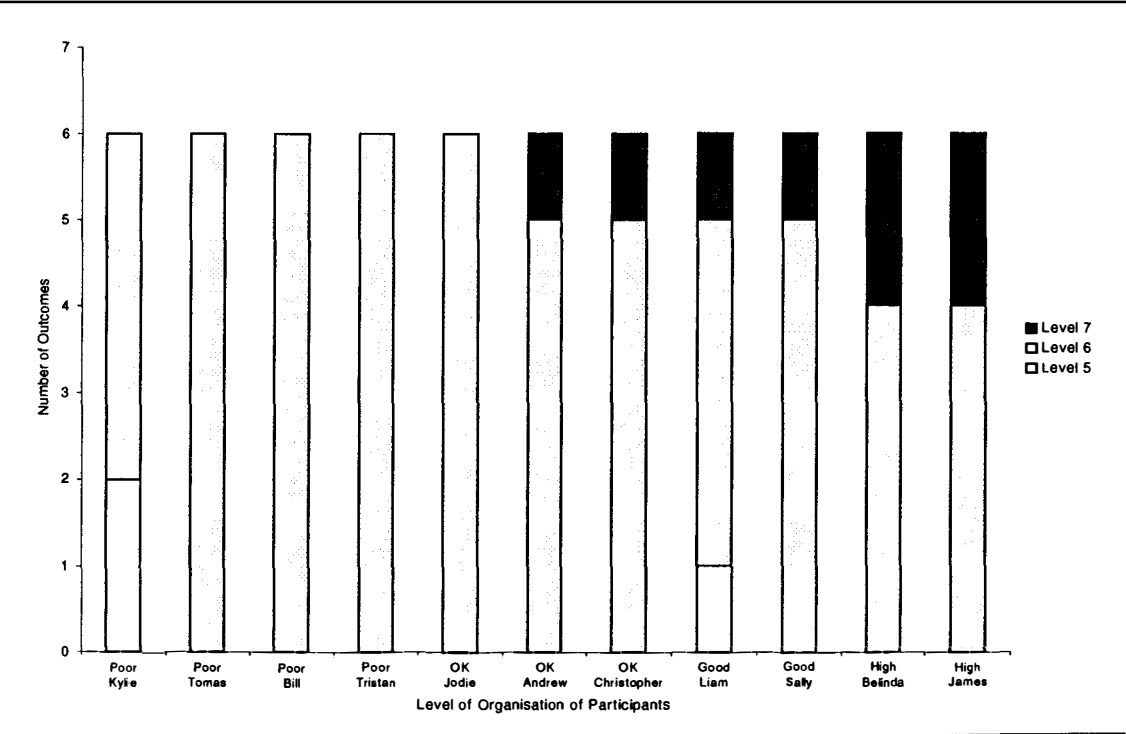


Figure 8: Level of student organisation against average level demonstrated in SOS.

From Figure 8 it is clear, that all participants were achieving at least in Level 6, in most Strands by the end of Year 9. The expected Level of achievement for Year 9 students, as shown in Table 1, is that students were expected to be working at least in Level 6 in all Strands. Table 1 showed in addition, that students were expected to be working in Level 7 in all Strands except the Working Mathematically Strand. Two students however had not demonstrated at least one Strand at Level 6. Interestingly, one of these students had good study skills and had demonstrated understanding at Level 7 in another Strand. No student with poor organisation skills demonstrated they were working at Level 7 in any Strand. This included Tristan, who, as discussed in Chapter 3, has demonstrated in other forms of assessment, that he had excellent mathematical ability. Therefore, reasons other than ability must be considered as to why some students had not demonstrated understanding at Level 7. Reasons may involve organisation and/or motivation in completing non-formal assessments (e.g., assignments) and study/revision skills before formal assessments (i.e., tests).

The findings of Oliver and Reeves (1996), that in studying by Telematics students have to adapt to a different learning environment, was strongly emphasised by participants in this research. Oliver and Reeves also stated that students need higher motivation and greater study management skills than in the face-to-face classroom. A number of participants adapted exceptionally well to the necessary study habits, one participant finding it a great benefit to be able to be given the work and the opportunity to organise her own study. In contrast though, at least three participants after two years of studying by Telematics had yet to develop adequate study habits.

Local Environment and Local Support

Those students, who had been receiving 'put-downs' from peers at their local school before studying by Telematics, commented this happened less once she/he studied by Telematics, and were pleased to be accepted by his/her peers. These comments agree with the EDWA (1996a) policy, which outlines the importance of students' talents being accepted and valued by their family and friends.

Dillon's suggestion that "the teacher can foster discussion processes by actively using non-questioning alternatives - statements, signals, silences ..." (Dillon, 1994, p. 78), has been shown to be impractical in the Telematics lesson. In practice, short verbal utterances like 'umm' or 'mm', were usually not heard over background noise, also

non-verbal signals are not possible in the Telematics environment. In fact, a number of students found that due to technology problems or background noise problems, their spoken contributions were not heard (an assumption made as the discussion continued without him/her).

A number of participants had family pressure to perform consistently high. Kristine's comments in particular illustrated a situation where the high expectations of both her parents and her teacher led to her choosing to underachieve. Kristine's experience strongly agrees with the statements of both Davis and Rimm (1994) and Abbott-Chapman (1994) who found parents teachers and peers all influence students and their decision to succeed or not. In contrast, a number of participants had positive encouragement and help with organising their study. The importance of encouragement for distance education students with organising their study was not found in other research.

The advantage of students having a local teacher willing to help with questions between lessons was commented on by a number of participants. The importance of a local teacher to assist, or alternatives such as better contact between student and Telematics teacher are issues not sufficiently considered by this research.

Research regarding working with a partner at the local school is lacking. Having a local school partner or not was an issue that participants found influenced how they felt towards studying by Telematics, and influenced their completion of work between lessons. Most participants agreed they would prefer not to be the only student at their school studying a subject by Telematics, in particular this would be advantageous as it would reduced loneliness and also provide help between lessons. Participants strongly felt, however, that having a local partner with whom she/he did not "get along with", would be worse than being alone.

Timetabling

Although previous research has not been found regarding Telematics students missing subjects at their local school due to Telematics timetabling, this was considered the biggest disadvantage of studying by Telematics for most participants.

Technology Equipment

The particular advantage of the technological equipment, namely having access to the 1800-number, has not been found in other research. It is however, an interesting advantage, which enabled students to attend classes even if they could not attend school. In addition, students and teacher had the advantage of access to technology, mainly e-mail, to communicate outside of class. The full benefit of using e-mail has not been investigated in this research, nor found in other research.

Oliver and McLoughlin (1997) discussed the advantage of real-time interaction for distance education students. However, other than the use of the computer screen, participants did not seem to recognise advantages in having real-time access to students of similar ability nor real-time access to their teacher. Students were very enthusiastic that they should have access to AV, allowing them to see each other, rather than only having visual communication by the computer screen.

Students stated they found it “annoying” when there were problems with connecting modems. Some other technology problems were avoidable through maintenance; others such as the weather that could not be avoided; and some, for example not sitting close enough to the microphone, students seemed to create for themselves. In agreement with Findley and Findley (1997), it is most likely, some of these problems were unavoidable and others could possibly have been avoided through regular maintenance.

Necessary Computer Skills

Although many of the participants had adequate computer skills before studying by Telematics, several students had very limited skills. A situation similar to that described by Collins and Bostock (1993), the solution of which Collins and Bostock found was to offer a “one-day intensive introduction” (p. 335) to computers. A similar optional course for prospective Telematics students would alleviate the disadvantages caused by being less familiar with computers.

Tristan’s attitude of not wanting to ask for assistance in learning more about technology is, in the opinion of the visiting teacher, in line with behaviours found in people with Asperger’s Syndrome.

Dialogue Examples

The first example illustrates the high interaction among class members. Fostering such interaction is described by Oliver and McLoughlin (1997) as essential. That students have such high involvement in all class discussions ensures the teacher has considerable 'feedback' regarding the understanding of the material and progress of individual students. In the opinion of the researcher, the greatest advantage of the Telematics environment is that the teacher can receive responses from all students regarding his/her understanding of the topic. The teacher can also ensure the misunderstandings of students are corrected before any discussion continues.

The second example outlines a number of problems occurring unexpectedly during a transmission. The occurrence and frequency of such problems requires that a Telematics teacher be a particularly flexible and patient teacher who is able to adapt to situations, which arise unexpectedly.

Summary

Participants in this study gave responses in agreement with researchers who hold that small class sizes and streaming for talented students are both beneficial (Berger, 1991; Davis & Rimm, 1994; Gursky, 1998; Lando & Schneider, 1997). Participants responses were not consistent amongst themselves, as for with the findings of other researchers, on such issues as the difficulty of having to organise his/her own study and the presence of a supportive local environment (Oliver & Reeves, 1996). All participants' felt the hardest aspect of Telematics arose if their transmission times and local mathematics lesson times did not align. The examples of Telematics transmissions illustrated lessons followed methods of learning involving high levels of interaction among class members. The examples also demonstrated Telematics lessons can provide, at times, numerous, and unexpected problems, requiring a Telematics teacher to be a particularly patient and flexible person.

The technology utilised throughout this study provided students with a number of advantages, in particular audio communication, text and graphical communication via the computer screen, access to lesson even if not at school, and communication between lesson via e-mail. Participants however, felt this remained somewhat limiting and were eager to have lessons transmitted via AV. The unreliability of the technology caused considerable disruption to lessons, although much of this unreliability was

possibly unavoidable. Not all participants had satisfactory computing skills before studying by Telematics and although it would be beneficial, students were not offered any such training before commencing study by Telematics (Collins & Bostock, 1993).

An Attempt to Dispel Isolation

Attempts to dispel isolation were mainly through encouraging students to know each other better and to work together. Issues surrounding students becoming more familiar and working together are discussed in the following.

Knowing others Personally

The comments of Findley and Findley (1997), on the importance of students feeling apart of the group were supported by many participants who, at least when they first studied by Telematics, felt isolated and others were unfamiliar.

McDonald and Gibson (1998) found that there was a high incidence of 'getting-to-know-you' conversations at the start of their research, which decreased over time. In this research, however, students were not found to initiate conversations of this kind, and it was only after the teacher made efforts to ensure students did get to know each other, that students then began volunteering personal information about himself/herself. Student conversation initially had been limited and usually only in response to teacher questions.

Throughout the data collection period, the teacher encouraged social interaction during the times when screens were loading. Collins and Bostock (1993) commented it is important to allow opportunities for both formal and informal conversation during lessons. In addition, Findley and Findley (1997), and Oliver and McLoughlin (1997), discuss the importance of allowing time during lessons for social interaction.

The closest incident to participants having an argument was Leslie and Kristine working on the joint assignment. This is in contradiction to Alvermann (1995) who found that many group discussions became arguments. Through out the research period, however, there were no arguments in any discussion; this was in line with McDonald and Gibson's (1998) research that also found no incidents of arguments.

Getting to know you out of Class

The enthusiasm of the majority of participants for 'getting-to-know-you' activities supports the suggestion by Findley and Findley (1997) that where meetings cannot be arranged, 'get-to-know-you' activities should. However, not all students held this eagerness or interest in meeting with their fellow classmates. In addition, some students, although enthusiastic to meet others, did not find meeting classmates to be of much help. This latter finding is in contradiction to Findley and Findley; therefore, rather than an assumption that familiarity between class members is important, a judgement should be made for each individual class.

Small Group Assignment

The case study by Peterson and Sellers (1992), found that learning styles need to be considered when forming cooperative groups. Although this study did not emphasise the small group assignment, participant experiences certainly tended more towards agreeing with Peterson and Sellers. In this research, most participants did not complete the assignment together as intended as they experienced too many differences between how they worked and their partner's approach. In addition, although Jim and Jamee completed the assignment together and Jamee was pleased with the results, Jim's comments tended towards preferring to work individually.

Summary

Participants' feelings when beginning to study by Telematics agreed with those of previous studies that found students felt isolated (Findley & Findley, 1997). Some participants were enthusiastic to meet with and know their fellow class members better; a practice strongly encouraged by some researchers, although other students were interested in learning not in social interaction (Findley & Findley, 1997). Although most participants were enthusiastic to meet with each other, there was no strong belief that meeting with each other was beneficial. Interaction with fellow students during the lesson was found to be an advantage for learning, although as most fellow students were from other schools, this was a disadvantage for communicating between lessons.

Learning through Dialogue

The teacher's attempts to facilitate learning through dialogue are discussed in the following sections.

Method of Learning by Sharing

It is particularly interesting to note that Forman et al. (1998) describe a method of learning, not unlike the one of learning by sharing that was utilised in this research. Forman et al. comment that this method resembles the practice of actual mathematicians. A student using the method of talking through a problem is what Meadows (1993) suggests helps with processing abstract thought. Students learning by elaborating on and discussing the material so they may better understand the material agrees with the ideas expressed by Yates and Chandler (1991).

Participants found the method of learning used during transmissions required more time, but was more beneficial than methods that were less interactive. Although the comments by Abercombie and Terry (1978) who found teachers tended to use "teacher talks and students listen", as it covered large quantities of material quicker, was a tendency the teacher struggled against.

Commenting on Another's Working

It seems that most students were not, as Love and Tahta (1991) described performing operations without thinking or by rote learning, although a few students seemed to prefer this method, as it required less effort. The majority of participants by the end of the data collection period were usually working through, unprompted, fellow students' ideas and working, and considering these against their own ideas.

Class Discussions

The experience of attempting class discussion during the limited time in transmissions corroborate comments by Abercombie and Terry (1978) that time for detailed discussions is possible during transmissions, although limited. In particular participants found the discussion in the mathematics lesson to be most useful when discussing methods ideas or different methods for solving problems. Most participants found it beneficial to their learning when fellow students shared how they had completed a question; however, some participants still perceived that mathematics

involved only tick or cross type questions and discussions were not relevant. Participants did not find class discussions beneficial if they were conducted too frequently or if the material being discussed was already understood. Class discussion time was found conducive to students feeling comfortable to ask questions or make suggestions. These issues concerning class discussions were not found in other research.

Role of Teacher in Class Discussions

Sally is possibly the participant who best described the role of the teacher as suggested by Dillon (1994) and Pettersson (1995) in that Sally felt the teacher helped most when she was unsure of her own thinking. Oliver and McLoughlin (1997) suggest the teacher taking the role of facilitator is needed, as it will better suit the Telematics environment. The teacher's notes referred more to her efforts to involve students in their own learning, and as such the lesson was usually teacher directed, rather than the teacher being the facilitator.

Interestingly, only one participant mentioned the importance of humour, a reference that is in agreement with EDWA's (1996b) comment on attributes of a teacher for the gifted and talented, namely they should include humour. The need for a teacher with a sense of humour also agrees with the comment by Findley and Findley (1997) on the need for the personal interaction of a teacher rather than impersonal technology.

Abercombie and Terry (1978) stated that times in a lesson when students ask questions and then the teacher responds is teacher directed and allows little time for group discussions. In this research, however, the intention was to encourage students to answer rather than the teacher, thus creating a student-centred learning situation. Such methods of learning / teaching as suggested by Abercombie and Terry and by Forman et al. (1998) were methods that the teacher attempted to implement in this research. A possible method where students comment on each other's work is suggested by Abercombie and Terry as an alternative to students listening passively to the teacher. Forman et al. (1998) presented an additional idea, and comment that if the teacher does not correct or respond on the accuracy of students' contribution but encourages other students the teacher will thereby encourage dialogue directly among students. The teacher noted numerous times in her field notes that as she initially prompted students to comment on the correctness of a question, students did begin to do this without

prompting. The teacher further noted her difficulty in changing her teaching methods, and she continued to want to reply to contributions for some time. The difficulty in the teacher changing his/her teacher style is an issue raised by Dillon (1994).

Student and/or Teacher Contributing

The issue of students responding to a question or contribution, rather than the teacher, had a positive response from most students, although the concern that students were not as qualified as the teacher to answer questions was raised. An issue Inagaki et al. (1998) considered, in particular that student responses may be incorrect, 'weak' or misleading. Inagaki et al. claim, in such situations students would sieve out the incorrect information and focus on the more 'plausible' ideas.

The situation described by Forman et al. (1998), where the teacher does not respond on the accuracy of a contribution, but invites students to comment or ask questions of the student who contributed. This method of interaction was encouraged throughout the data collection period. Participants found this a beneficial method of learning, especially as students had to think about contributions in order to reply to them.

Students gave various reasons for not wanting to talk; for example, afraid the response would be considered silly, or that she/he was not correct, or that they would gain a negative response from others. These findings agree with those of Alvermann (1995) who found similar reasons for students choosing not to contribute. The participants, who preferred not to contribute from fear of being wrong, are in agreement with the comments by Dillon (1994), who stated that gifted students are used to being right and do not want to risk being wrong. The situation where a student received no reply after having contributed was mentioned by Harasim (1990). Harasim commented that not receiving a response after contributing was a main concern with students deciding not to contribute to a later lesson. This particular reason for not contributing, however, was not mentioned by participants.

Alvermann (1995), and Oliver and McLoughlin (1997), commented that one main reason students do not talk is that the teacher is usually talking. In this study however, only one student made any such comment. The fact there were no other such comments from students perhaps because students felt intimidated to mention this, or may be the students did not feel the teacher did talk too much. It should be noted though, that in the final page of the anonymous questionnaire, students were asked to

state if they had felt intimidated at all during the interviews to state what they really thought, and students overwhelmingly replied, “no”.

The other question concerning teacher-talk was mentioned by Prawat (1997). Prawat discussed, that if in a particular topic student knowledge is limited, then students do not have to provide all the answers; and in this situation, it may be necessary for the teacher take the lead. A number of participants agreed it was important that the teacher be involved in discussions, particularly when his/her understanding of a topic was confused or ‘stuck’.

Alvermann’s (1995) comments on girls not speaking-up as much with the onset of puberty may be the reason Sally and Belinda were not as outspoken as some members of their classes. Although, Kristine and Jamee were both particularly keen to contribute to discussions in their class. In contrast, some of the boys, like Tomas, Tristan and Jim were as quiet or contributed even less than Sally and Belinda. However, the number of participants in the study was limited so it is not possible to discount nor agree with Alvermann’s claims.

The statements of Simonson (1997), and Oliver and McLoughlin (1997), who found students prefer the face-to-face environment because of the interaction possible in the face-to-face classroom are both confirmed and contradicted by participant comments, as these examples demonstrate. Jim’s comment, that it would be good if he could talk to others personally as in a classroom, are opposed by those of Leslie who found Telematics has the advantage as discussions are more interactive than the ‘regular classroom’.

Helpfulness of Other Students

Figure 9 graphically shows the data presented in Table 8. The numerical ranks in Table 8 have been combined in the following manner. The ranks of one (low), two and three are combined as ‘low’; the ranks of four, five, six and seven are combined as ‘middle’; and the ranks of eight, nine and ten (high) combine as ‘high’. Participants who declined to rank one classification, or for whom the question was not relevant, are not presented in the graph.

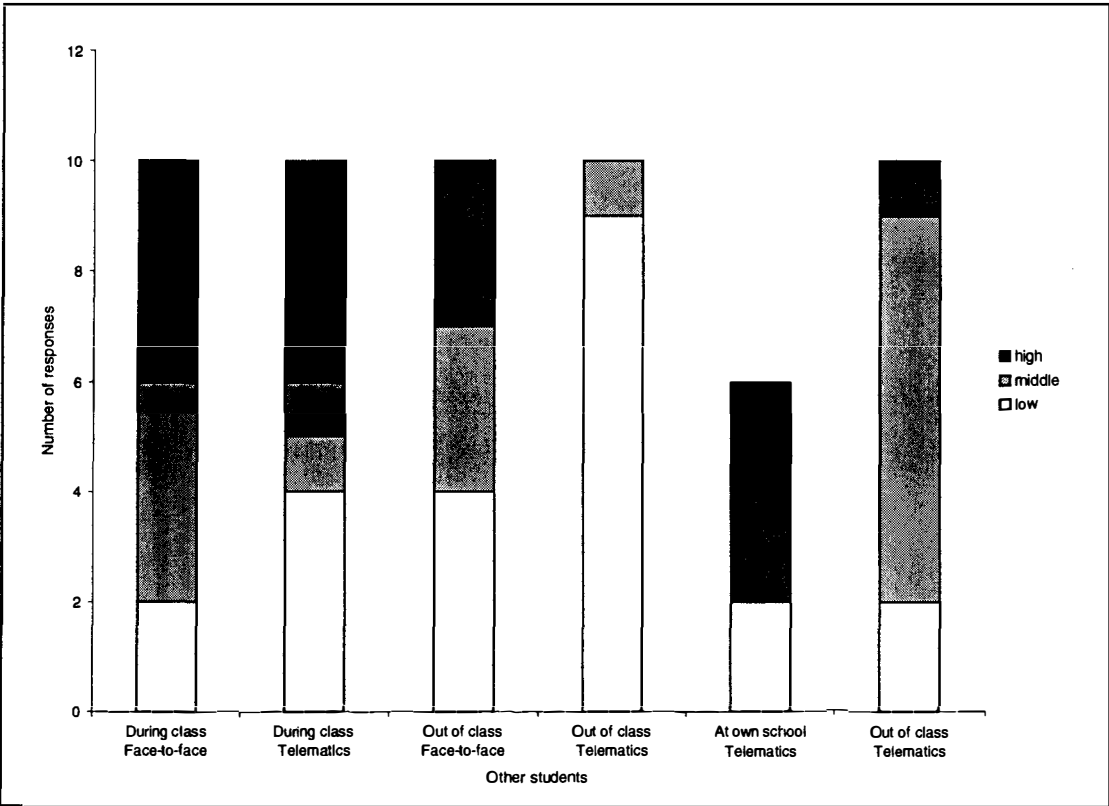


Figure 9: Comparison of importance of students for learning, in the face-to-face and Telematics lessons, and in their own and other schools.

Figure 9 shows that participants found other students were most helpful to their learning in the face-to-face classroom, and Telematics students during the Telematics lesson. A Telematics partner, if present, at the same school was only commented by six participants, although most of these found their current or previous partner to be helpful. The majority of participants found fellow Telematics students to be of no help in learning his/her course material outside of the Telematics lesson. Figure 10 was generated in an identical manner from Table 9, as Figure 9 was generated from Table 8. Figure 10 considers how helpful participants found fellow Telematics students in completing assessments.

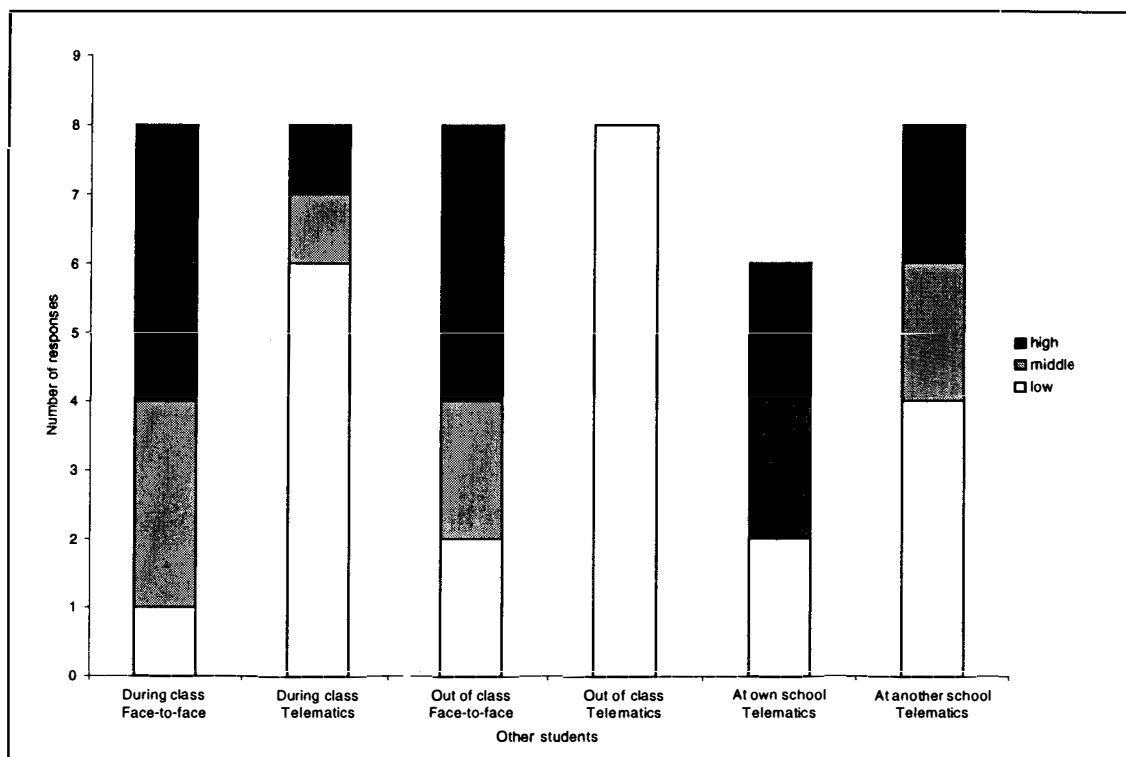


Figure 10: Comparison of importance of students completing assessments, in the face-to-face and Telematics lessons and in their own and other schools.

The opinion of participants on the helpfulness of other students in completing assessments is very similar to the opinions expressed regarding helpfulness in learning course material. That is, other students were considered most helpful in the face-to-face situation, although to a lesser degree, and a Telematics partner at the same school was again considered helpful for some participants. In contrast, however, fellow Telematics students during the lesson were not perceived as helpful for completing assessments.

The importance of other students for learning during the lesson agree with the statements by Oliver and McLoughlin (1997) that interactivity is essential in distance education for "... deep and meaningful learning to occur" (Oliver & McLoughlin, 1997, p. 10). However, even with the availability of e-mail, and its common use in some instances for social interaction, communication between lessons with students or teacher at a different school was not considered to be useful for understanding work or completing assessments.

Summary

The suggestions for interactive lessons as described by Forman et al. (1998), Meadows (1993), and Yates and Chandler (1991) were attempted during this study and were perceived to be positive. Although as Abercombie and Terry (1978) suggest, the teacher did find it difficult to change her teaching methods; however, as Love and Tahta (1991) suggested, some students preferred not to be actively involved in their own learning. Class discussions were in general perceived positively, with the role of the teacher considered to be best as a facilitator; a finding in agreement with a number of researchers (Dillon, 1994; Oliver & McLoughlin, 1997; Pettersson, 1995).

Participants commented on a number of reasons why students choose not to contribute to lessons, many of which were already identified by other researchers (Alvermann, 1995; Dillon, 1994; Harasim, 1990; Oliver & McLoughlin, 1997). Students were divided on the issue of whether interaction was better in the Telematics or the face-to-face lesson, both agreeing and disagreeing with comments by other researchers (Oliver & McLoughlin, 1997; Simonson, 1997). The helpfulness of learning with other students in the Telematics environment found, that during lessons other Telematics students were helpful, although between lessons they were not.

Summary of Discussion

The findings of this research both confirmed and contradicted educational theories and the findings of other researchers. For example, class discussions where the teacher acted as facilitator, encouraging student participation and students to respond to each other was considered favourably both by other researchers (Forman et al., 1998) and the findings in this research. However, issues raised by researchers (Findley & Findley, 1997) concerning the importance of familiarity among class members, in particular the importance of meeting with each other face-to-face was not considered as beneficial by participants.

Participants raised a number of influences that were not found in other research. In particular, issues surrounding the presence or absence of a local school partner and the interaction between these students were of particular importance to the participants although not researched previously.

Chapter 6 Conclusion

Initially outlined in this Chapter are the limitations of the findings in this research. In addition, the implications for Telematics teachers and the implications for further research on learning in the Telematics environment are discussed. The Chapter closes with a statement of the conclusions drawn from this research.

Limitations

The findings in this research are limited due to two reasons; firstly, the recorded lessons were not necessarily true representations of 'usual' lessons. Secondly, the make-up of the classes involved in the research and the fact the researcher was a participant might be considered limitations. These aspects of the research are discussed in more detail in the following sections.

Problems with Recording Class Lessons

Of the three-recorded lessons, not all students were always present. This limited the validity of data collected through the recorded lessons on the interaction of students in the lesson. However to compensate this limitation, written notes were made for those lessons that were not recorded.

A second limitation with the recorded lessons came about with the third recording of lessons. This particular lesson was not a 'typical' lesson, as the lesson involved a statistical data collection activity rather than a class discussion of mathematical ideas and working through mathematical problems.

One-sixth of transmissions throughout the data collection period were recorded which might not have provided a true indication of the interaction of students. However, recording additional transmissions was not practicable. The recorded lessons were however equally spaced throughout the period diminishing effects from not recording each transmission; also, field notes were recorded by the teacher during all transmissions.

Participants

The three classes in the research were similar in make-up, in that they consisted of two students on their own and two students from the same school. All three classes were also similar in that they had only four students in each class. However, this was not chosen deliberately and in fact the classes were formed at the start of the school year based on teacher and student availability times.

Many Telematics classes consist of a small group from one school. This study does not take into account the affect of such a group existing, when the study was proposed there was one small group, but the third student withdrew from the Program immediately before the research began. Issues regarding the influences of a small group at one or more schools in a Telematics class have not been considered in this research. This situation in particular occurs in most Telematics classes, and influences interaction and familiarity between students considerably, aspects of learning by Telematics this research does not consider. In addition, many Telematics classes consist of eight or more students. This study did not consider issues regarding such larger classes. For instance the following are not considered regarding larger classes: if there is any difference in interaction between students, the frequency of class members contributing to discussions and the teacher gaining satisfactory responses on understanding and progress from all students.

A further issue regarding participants was that the researcher had taught five of the students in the year before the research, whereas the remaining students were considerably less known, and there was far more familiarity between those five students and the teacher.

As the researcher was a participant there is an internal validity concern that a researcher's own objectivity may have been "... affected by their close involvement in the group ..." (Cohen & Manion, 1994, p. 111). A further limitation was the small numbers of participants, which limited the quantity and variety of responses in the research. The number of responses also inhibited generalisations being drawn from the findings of the research.

Implications for Teaching

The results of this study have shown that where the teacher changes his/her teaching methods to better suit the environment, students will change their role in the lesson to one where they are more actively involved in their own learning. To ensure that such optimal teaching practices occur it is recommended that, a Telematics teacher should be willing and able to practice the following:

- ◆ Encourage students to be involved in their learning through talking, in particular:
 - The teacher would not dominate the lesson through his/her own talking, and
 - If a student is continually reluctant to contribute, discuss with the student how she/he would feel more at ease to contribute during the lesson;
- ◆ Give students the opportunity to raise any concerns or suggestions they have regarding learning by Telematics; and
- ◆ Assist students to adapt to the Telematics learning environment and their role in the learning environment, specifically by:
 - Encouraging the types of contributions the teacher would like the student to make, and
 - Ensuring that students have the time and opportunity to make such contributions.

In order for a teacher to suit the Telematics learning environment for ATP students, she/he would be predisposed to the following personal qualities:

- ◆ Be willing to change his/her current teaching practices to those optimal for the Telematics environment;
- ◆ Be willing to cater for the needs of ATP students studying in the Telematics environment, in particular:
 - Put himself/herself in the place of the Telematics student, especially in considering the isolation of the student, and

- Allow for the fact that the students are not adults and therefore are not adept at voicing their educational and personal needs;
- ◆ Be flexible / adaptable to changing and unexpected situations;
- ◆ Speak with clear and precise enunciation; and
- ◆ Have a sense of humour.

In order for optimal teaching practices to occur in the Telematics learning environment, EDWA needs to undertake the following:

- ◆ Select teachers based on criteria that ensure they are well suited for teaching ATP students in the Telematics learning environment; and
- ◆ Provide professional development for current and potential Telematics teachers and ensure that such teachers are aware of the needs of ATP and Telematics students and how to cater for these needs.

In summary, to teach an ATP course through Telematics and to be successful, teachers should be aware of their role in the learning, based on the needs of the students. Moreover, the teacher must have the qualities suited to teaching Telematics lessons, and be someone willing to change his/her teaching practices to make them optimal for the Telematics environment.

Implications for Research

Further research is required for classes of more than four students studying through Telematics. For example, does the larger-sized class influence class discussions and the teacher's ability to assess student knowledge and understanding during lessons? In addition, if there are large numbers of students at one site, how does this influence interaction between students at different school sites?

Research is also required into assistance for students between lessons. For instance, does better access to fellow Telematics students and the Telematics teacher (for example using WebCT) between lessons assist Telematics students?

Conclusions

This research set out to determine the advantages and disadvantages of talented students learning mathematics in the Telematics lesson. Most notably, it was found that whereas some students would find one issue a considerable advantage, other students would find the same issue an equally consequential disadvantage. This situation occurred in the majority of issues considered in this research.

The issues that were clearly a disadvantage to learning for all students were firstly, the unreliability of the technological equipment and secondly, when Telematics transmission times did not align with the local-school mathematics times. The latter situation caused ongoing problems for an individual student, the former, caused problems for class members in a particular lesson. The teacher or organiser can make every effort to align transmission times with local-school mathematics times and reduce the frequency of the problem involving timetabling occurring. The problem of unreliable technology, other than reasonable maintenance is not an issue in the control of the teacher.

The issues all participants agreed were advantageous to learning an ATP course by Telematics were that classes were small and that the classes did not include lower ability students (i.e., that classes are streamed). Although in this particular research the classes were smaller than many Telematics classes, and whether or not students in larger classes still find this satisfactory has not been investigated.

The following issues are those that participants varied in their opinion of, some finding the issue a distinct advantage, others finding it not influential and others a particular disadvantage. Current technology provided students communication with other students and their teacher, although the technology is somewhat limiting and students would prefer lessons by AV. To study through a technology medium students needed to have or to acquire certain computing skills, an excellent opportunity for some students and the cause of additional work and inconvenience for other students. Learning externally for some students was a particularly isolating experience, with many students feeling inhibited to contribute to a class consisting of 'phantom classmates', although for other students it was an excellent opportunity to learn with other talented students. Allowing time during lessons for social interaction was considered a difficult time, to interact personally with unknown persons, unnecessary

by others and an essential element of the learning environment for other students. Opportunities to meet face-to-face were greatly beneficial for some students and unimportant but interesting by most students.

Although a number of students communicated socially outside of transmission by use of e-mail, students did not find fellow classmates from other schools to be helpful with their learning between classes. Some participants found fellow Telematics students at their own school to be helpful with their learning between classes, although others experienced either some or considerable personality differences with their local school partner. Some students took full advantage of the interactive method of learning, communicated directly with fellow classmates, and contributed their own ideas rather than only answer direct questions from the teacher. Many students however, for various reasons, preferred to contribute only when specifically responding to questions from the teacher.

In summary, this study found that for talented mathematics students learning in the Telematics environment, most aspects of the learning environment were not conclusively an advantage or disadvantage. As such, in order for the individual students to excel in studying in this environment, the Telematics teacher needs to determine the aspects of their learning environment particular students are finding difficult. The teacher then needs to help the individual to overcome or adapt to these aspects of their learning environment.

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Appendices

Appendix I - Interview Questions

Questions all students were asked

1. What things do you find are good about learning by Telematics?
2. What things do you find are not so good about learning by Telematics?
3. Do you feel it would make it easier to talk with other students if you knew them better?
4. I believe that in Science you have many discussions. How do you find learning by discussions, as opposed to say, working through the theory and then worked examples?
5. Do you think discussions could work as well for mathematics as for science?
6. If you had a choice, would you prefer to be by yourself or with someone else? Why?
7. What contact, for social or work, have you made with students from other schools outside of class, say by e-mail or telephone?
8. Do you feel you have the opportunity to ask questions you need to of your Telematics teacher/s?
9. During transmissions, are there any distractions in the area where you have your Telematics lessons?
10. If you had the choice would you prefer to have your lessons by Telematics or in the face-to-face classroom?
11. How important do you think it is to know other students and your teacher personally?
12. How difficult do you find the course material, do you find it too difficult, too easy?
13. During a lesson if someone gives an answer or makes a comment that you do not feel is correct or is not complete in some way, do you feel okay about speaking up and saying what you think?

14. If someone disagrees with something, you have said. Do you have a problem with him or her correcting you?
15. Sometimes, in some classes, there will be one student who always jumps in and answers all the questions. Or, perhaps the student is always talking, either socially or about their work. What do you think about students who talk too much during a lesson?
16. Sometimes in some classes there will be one or more students who do not contribute to the lesson, so it's left to the others to do all the work. What do you think about other students who talk too little during a lesson?
17. If during a lesson I decided not to answer student questions or make corrections of student mistakes but leave up to other students, how do you feel about talking directly to other students rather than to the teacher?
18. Whom, out of teacher and students, do you think usually answers queries and corrects mistakes?
19. Would you give equal weighting to a student or a teacher to answer a question or make a correction?
20. Do you see any benefits from students rather than the teacher answering the question?
21. Do you accept answers from students and teachers without a problem, or do you in your own mind question what they have said or do you work through their answers yourself to make sure it is correct?
22. Do students usually come up with clearly understandable explanations?
23. Time taken for each student to write examples and answers on the screen - do you think this is beneficial or that it takes a long time and is boring?
24. If a student gives an answer / explanation and you do not feel it's complete or contains some error - do you feel comfortable voicing your comments?
25. Do you find it easy or intimidating to add in comments on material during lesson?
26. Do you have any opinions or thoughts on learning by Telematics that you would like to make clearly or that you have not said yet?

Questions asked of students with, or have in the past had, a Telematics partner

- 27. What is something good about having someone else at your school?
- 28. What is something not so good about having someone else at your school?

Questions asked of students who attended one of the “get-togethers”

- 29. How well did you know the other students before meeting them at Mount Meet / Trip Valley?
- 30. Before meeting with the other students, what did you think about learning with people you did not know?
- 31. Before the meeting was it difficult, talking with people you did not know?
- 32. How well did the meeting help you to know the other students?
- 33. Do you find it easier talking with the other students since the meeting?

Questions asked of students who have not met other students

- 34. Is it difficult talking with people you do not know?

Appendix II - Questionnaire

Please return this questionnaire as soon as possible using the enclosed stamped and addressed envelope. The envelope can be posted or placed in the Mail West bag.

This is an anonymous questionnaire. Please ensure that you do not write your name, or any other comments that will make you identifiable. By completing the questionnaire, you are consenting to take part in this research. As such, you should first read the Consent Form you received at the start of this research.

Qu 1. When you first started studying by Telematics what was one of your biggest problems in getting used to studying by Telematics?

Qu 2. When you first began studying by Telematics, how reluctant were you to contribute to any discussion in the lesson?

(1 = very reluctant, 10 = not reluctant at all). Circle one: 1 2 3 4 5 6 7 8 9 10

Qu 3. How reluctant are you to contribute to any discussion in the lesson now?

(1 = very reluctant, 10 = not reluctant at all). Circle one: 1 2 3 4 5 6 7 8 9 10

Give some reasons why you feel a student might be reluctant to contribute during a Telematics lesson.

Qu 4. Give some reasons why you feel a student might be reluctant to contribute during a Telematics lesson.

Qu 5. What things do you feel could help a student, or have helped you, feel more inclined to contribute during a discussion in the Telematics lesson?

Questions 6 and 7 relate to completing or discussing school work, this could be at home, during a study period or during a lesson. Questions 6 and 7 do not relate to completing or discussing work for assessments.

Qu 6. For subjects you study in the face-to-face classroom, how important / helpful to you are other students both in the classroom and out of the classroom, in completing and understanding your school-work? (1 = not important, 10 = very important).

In the classroom Circle one. 1 2 3 4 5 6 7 8 9 10

Out of the classroom Circle one. 1 2 3 4 5 6 7 8 9 10

At your school Circle one. 1 2 3 4 5 6 7 8 9 10 no other student
At other school/s Circle one. 1 2 3 4 5 6 7 8 9 10

(1 = not helpful, 10 = very helpful).

During Telematics lesson	Circle one.	1	2	3	4	5	6	7	8	9	10
Outside of Telematics lesson	Circle one.	1	2	3	4	5	6	7	8	9	10

Qu 8. For subjects you study in the face-to-face classroom, how important / helpful to you are other students (both during the lesson and out of the classroom), in completing and understanding assessments? (1 = not important, 10 = very important).

During lesson Circle one. 1 2 3 4 5 6 7 8 9 10

Out of the classroom Circle one. 1 2 3 4 5 6 7 8 9 10

At your school Circle one. 1 2 3 4 5 6 7 8 9 10 no other student

At other school/s Circle one. 1 2 3 4 5 6 7 8 9 10

(1 = not helpful, 10 = very helpful).

During Telematics lesson	Circle one.	1	2	3	4	5	6	7	8	9	10
Outside of Telematics lesson	Circle one.	1	2	3	4	5	6	7	8	9	10

Qu 10. The primary focus of this research is students (studying by Telematics) learning together. Please use the space below, or attach a separate sheet of file paper, to make any comments you may have on learning in the Telematics lesson and specifically learning with other Telematics students.

[illegible]

100

Student feedback on their involvement in the research

Qu 1. Did you feel you were given the opportunity to contribute the information you thought important during the research?

(1=strongly agree, 5=strongly disagree). Circle one 1 2 3 4 5.

Qu 11. Did you feel you were able to answer questions as you honestly thought?

(1 = always, 5 = never). Circle one 1 2 3 4 5.

Qu III. Did you feel questions were clear and you understood what was being asked?

(1 = always, 5 = never). Circle one 1 2 3 4 5.

Qu IV. Before beginning the research did you feel you knew what the research was about and why you were involved? (1=strongly agree, 5=strongly disagree). Circle one 1 2 3 4 5.

Qu V. Towards the end of the research did you feel you knew what the research was about and why you were involved? (1=strongly agree, 5=strongly disagree). Circle one 1 2 3 4 5.

Qu VI. Do you feel you were given the opportunity to ask any questions you had about the research, and about your involvement in the research?

(1=strongly agree, 5=strongly disagree). Circle one 1 2 3 4 5.

Qu VII. Answer only one of the following questions regarding any questions you may have asked the researcher about the research.

(a) Do you feel your questions about the research were answered satisfactorily? (1=strongly agree, 5=strongly disagree). Circle one 1 2 3 4 5.

(b) If you did not ask any questions – please comment why you might not have actually asked the questions you had (or perhaps you did not have a question).

Qu VIII. If you have any further comment about your involvement in this research or the way the research was carried out, please comment below.

This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Please continue over page if necessary).

Appendix III – Student Article

Our Visit to Tripville

by Tomas

Our math's class (Miss Clarke, Sally, X, Tristan and myself Tomas) came to Tripville one Sunday afternoon. I met every one for the first time except Tristan, who I work with. It was a big surprise nobody was what I had expected them to be. We went and played mini golf. It was silent at first nobody would talk. After a couple of bad shots of golf, we all started to talk and start a conversation.

We then went for a walk across the Tripville River and found a quite spot to play basketball while the parents talked. Our team lost but only because we were out numbered (I swear!). We stayed there for a while then we started walking back. We talked for a fair while and then said our good byes. It was a great afternoon and greatly enjoyed by all. It finally put a face to those well-used names.

Note “X” is a student who did not a participant in this research.

Appendix IV - Dialogue Example (A typical Lesson)

Some background to the dialogue

Belinda and Bill have found it difficult to complete the quantity of work for their mathematics as their school only allocates three hours to mathematics a week, and must complete most of their work at home. Belinda and Bill sit at the back of the face-to-face Year 9 mathematics class, although not together, and complete their ATP mathematics work. If he has time, the mainstream teacher is happy to answer questions if any problems arise. Both students prefer to work through any problems themselves, but if necessary Belinda will ask her father for help at home. Bill does not have help available to him at home.

Christopher has only one complete mathematics lesson, as his other lessons over-lap ATP mathematics and science transmissions. For the lessons that over-lap transmissions he remains in the library to work on his homework; the librarian is a trained mathematics teacher and is happy to answer the few questions Christopher asks. Andrew completes his work at the back of the mainstream mathematics classroom. The teacher is not keen to assist if he has any questions, but his father is able to help him after school. Andrew's parents check his progress and ensure he is not falling behind in his work.

Both Christopher's and Belinda's parents assist them with organising their study time making sure they do not fall behind with their work, or spend too much time studying. Bill's parents do not assist him in organising his study; Bill however has very poor organisational skills and is often behind.

Christopher in particular found it very difficult to be studious in the regular classroom as his fellow students were completing considerably less quantities of work than himself and the effort required of him is considerably more.

Miss Clarke announces to the 30 or so students in her current face-to-face class that they should now stop their current activity, and proceeds to announce what is required to be completed for homework. After the students have left, Miss Clarke locks the door on her way to her next class.

Belinda finishes the last mouth-full of her slice and tells her friends she will see them later and heads for the Telematics room.

Bill is playing basketball and has not remembered he has to watch the time and go to his lesson before recess has finished.

Christopher is lucky his mathematics transmission could be timetabled at the same time as Year 9 students have mathematics, so he does not miss a class. He goes straight to the library where the Telematics equipment is set-up. He frowns as he watches a class of Year 3 (eight-year-old) students being led into the library by their teacher.

Andrew explains to the relief teacher in his Geography lesson that he has to go to a transmission now. He breathes a sigh of relief when he is given permission straight away and does not have to go into a whole explanation.

Miss Clarke walks into the Telematics room, past numerous work-stations set up, each with a computer, a number of modems, plenty of desk space and a chair. Miss Clarke checks the board for which workstation she is assigned for the transmission, the computer has been left on by the previous teacher and Miss Clarke uses the mouse to double click on the icon for Electronic Classroom.

Belinda enters the Telematics room, which is a converted storage room. It is set up with two sets of Telematics equipment, due to the large number of students studying Telematics at that school. Three other students in the room are part way through their ATP English lesson and are involved in a conversation with their teacher. Students need to speak clearly to be heard by their classmates and teacher, as such the other students are clearly heard by Belinda and their conversation will be in competition with Belinda's and Bill's when their lesson begins. There are a number of sets of headphones and microphones in the room. Belinda turns on both her modem and computer and waits for the computer to start-up. Belinda dials the 1800 number and enters her pin.

Bill still has not remembered to cut short his recess today and is enjoying his game of basketball.

Christopher turns on his computer and modem, puts on the headphones and dials the 1800 number, enters the pin and sits listening to the classical music until he is connected to his lesson. Meanwhile, his computer has started and he double-clicks on the Electronic Classroom icon. When Electronic Classroom has finished loading, Christopher has the modem dial to connect with Miss Clarke.

Andrew arrives at the Learning Centre at his school, which is mainly used for students with learning difficulties, but has a part set-aside for Telematics transmissions. On arriving though, he found no one else there and the doors are locked. Andrew sets out to find a teacher who can open the doors, which is a small problem as the Learning Centre is at the far end of the school.

Two minutes before the scheduled start time Miss Clarke puts on the headphones and calls the 1800 number, enters the pin and waits for the beeps that sound as each site joins the lesson. Two beeps sound.

The lesson begins

Miss Clarke: Hello.

Belinda: Hi Miss Clarke.

Christopher: Hi.

The screeching sound of modems connecting is heard down the telephone line.

Miss Clarke recognises the voices of the students from experience and greets them individually.

Miss Clarke: Hi Belinda, Hi Christopher. How was your weekend?

Christopher: Oh yeah, it was OK.

Belinda: All right.

Miss Clarke: Belinda, is Bill there?

Belinda: No. I'm not sure where he is, I'm not even sure if he's at school today.

Miss Clarke: Christopher was that you connecting?

Christopher: Yes and I have a full bullet so I'm connected properly.

Miss Clarke: Yes good! Belinda, are you ready for me to call your modem?

Belinda: Yes.

Christopher: I wonder where Andrew is too.

Miss Clarke: Yes it's not like Andrew to not leave a message to say he won't be at a lesson.

Belinda: Miss Clarke, Bill has just arrived.

Bill: Hi Miss, sorry I'm late.

Miss Clarke: Hello Bill. Why are you late?

Bill: Oh, I was ... just ...

Miss Clarke: Okay Bill. So how was your weekend?

Bill: Oh it was great. I [continues]

As Bill continues, Miss Clarke and Christopher offer comments, while simultaneously attempting to connect modems. A little later is heard in the background the screech of the modem connecting to Belinda and Bill, the sound nearly drowns-out the voices in the conversation. A little later, a beep is heard and Andrew is connected. Andrew has already dialled his modem and all students can hear down the phone-line the screeching of Miss Clarke's and Andrew's modems as they connect. Miss Clarke begins transmitting the first pre-made lesson file to the students.

Bill: Hi Andrew, you're a bit late aren't you. That's all right because I was too.

Andrew: Yes. Hi. The Learning Centre was locked and I had to go and get a key. Hey Miss Clarke, you know that work you sent out I started doing that but I don't think one of the answers is correct.

Miss Clarke: Hi Andrew. Which question was that? Does everyone else have that worksheet there; we can see what others got for the answer.

Andrew: It was ... I'm just looking ... it was question 4(b).

Miss Clarke: Okay, what did you think the answer was Andrew?

A small discussion followed about how students completed the question and the answers they gained, with the exception of Christopher who states he has not had time to try the question yet. Belinda and

Christopher agree with Andrew, after which Miss Clarke confirms the answer gained by the students.

Miss Clarke: Okay, Last lesson we were discussing what? [discusses trigonometric ratio's and asks a couple of revision type questions].... So let's move on to some problems where we can use all of these.

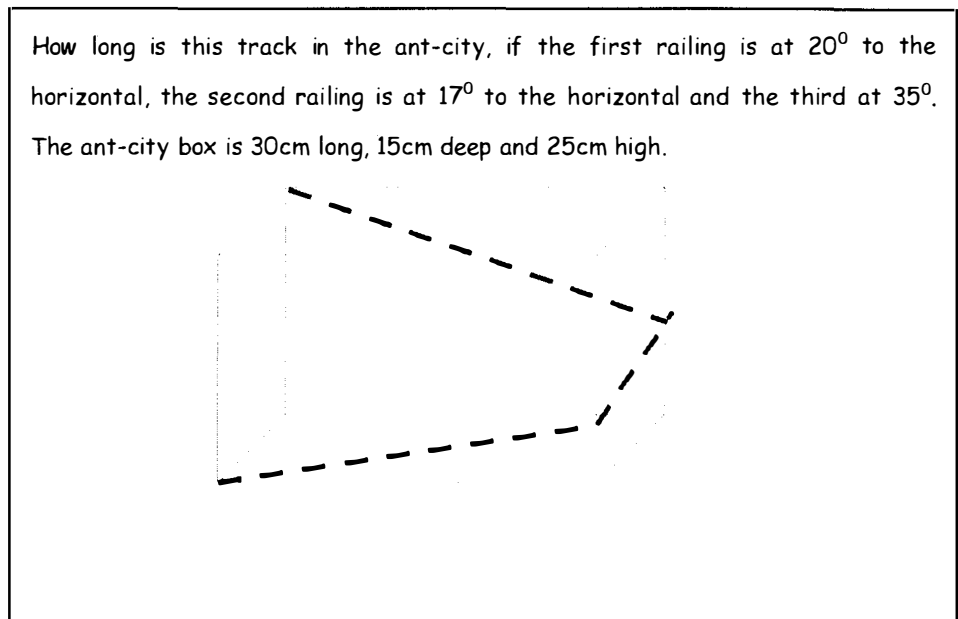


Figure 11: Lesson in progress, example Screen 1.

Miss Clarke: Let's work through this question together. Christopher could you read the question please?

Christopher: Yes. How long ...[continues]

Miss Clarke: Thankyou Christopher. So! What is the first step here, anyone?

Bill: Well, ...

Silence

Miss Clarke: Yes?

Andrew: You'd have to draw separate triangles wouldn't you, so you can work out each one?

Miss Clarke: What does everyone else think?

Boys collectively: Yeah.

Miss Clarke: OK, who's turn is it to write?

Christopher: Bills.

Miss Clarke: Thanks Bill, can you create a new screen and draw our new triangles.

Miss Clarke passes control to Bill, who quickly sketches the three triangles as in Figure 12.

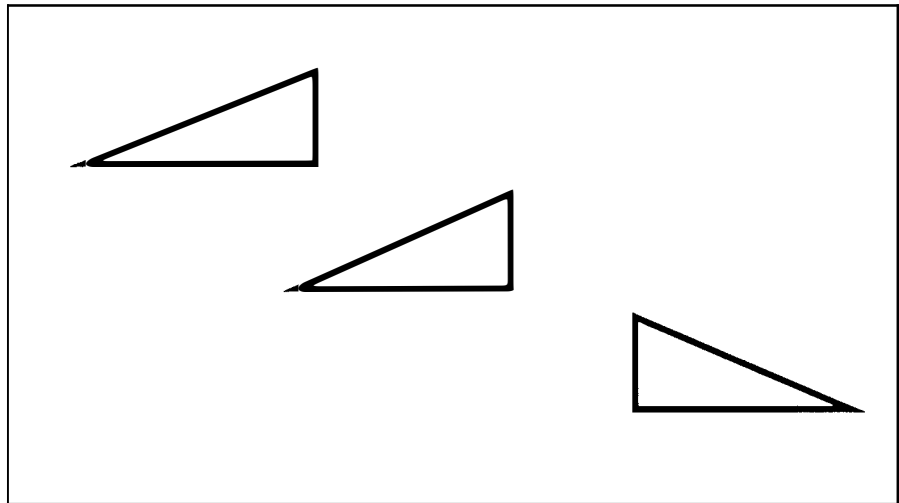


Figure 12: Lesson in progress, example Screen 2.

Miss Clarke: Thankyou Bill, what do we need to do next?

Christopher: We need to write the numbers and angles and stuff in.

Bill: Yes Christopher's right.

Miss Clarke: OK, can you write those in please Belinda? What can we do now?

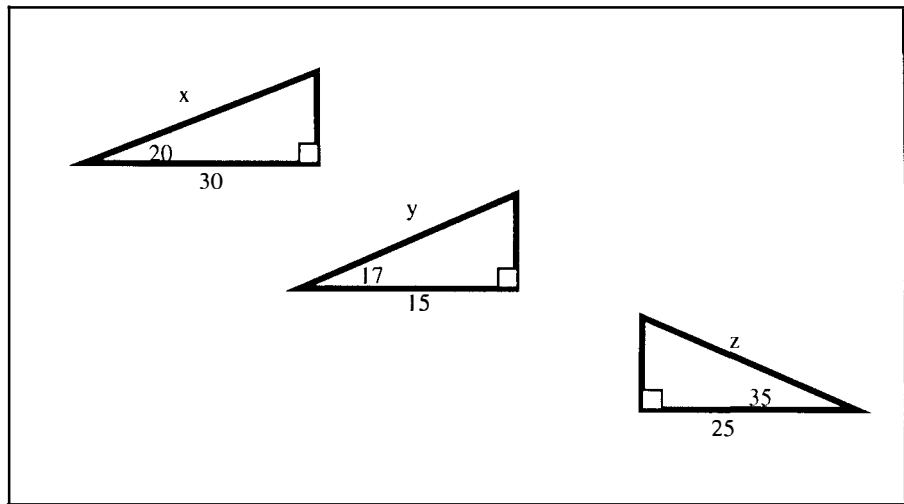


Figure 13: Lesson in progress, example Screen 3.

Belinda: Well, in the first triangle we'd use the sine ratio wouldn't we?

Miss Clarke: Anyone else?

Bill: Oh, we get it now Miss Clarke, can't we just do them ourselves?

Miss Clarke: Yes, if you like, would anyone else like to go through one of them first?

No reply.

Miss Clarke: Um, just before you start, lets divide the parts up, Belinda and Christopher can you both do the first one and Bill and Andrew do the second one. We'll do the last one in a minute.

Silence as students work on their own questions. When finished, pairs working on same question are asked to compare how they completed the question and the answer they gained, to see if they agreed.

Miss Clarke: Very good. How could we check if our solution is correct or at least reasonable?

Andrew: Well, we know, like for the second one that the side's 15, so we know the hypotenuse has to be bigger than 15.

There is some noise coming through the headphones.

Miss Clarke: Thankyou Andrew. Does anyone know what that noise is?

Christopher: Yes, there's a class in here.

Miss Clarke: Oh, okay, could you turn your mike off please.

Christopher turns his microphone off and there is no background noise transmitted down the phone-line.

Miss Clarke: Back to Andrew. Who'd like to comment on what Andrew said?

Silence.

Miss Clarke: OK, but is there anything else we can check to see if our hypotenuse is a reasonable length?

Belinda: Miss Clarke?

Miss Clarke: Yes?

Belinda: Well, couldn't you use that Pythagoras thing, 'cause, well, since the opposite,... Well, because the angle's 17, the opposite side isn't going to be very big, so between that side and 15, the hypotenuse isn't going to be much bigger than 15.

Pause.

Christopher: Ohhhh, Yeah!

Andrew: Yeah, what she said.

Miss Clarke: Bill?

Bill: Umm, yeah, I get it.

Miss Clarke: Well done Belinda. One last thing to consider is the setting out, if we were writing this all out, how would we do that
[continues...]

When finished, Miss Clarke deletes the screen and loads the next. While the next screen is loading Bill, Christopher and Andrew discuss computer games and e-mail accounts etc. When the next screen is loaded, Miss Clarke calls attention back to the screen. Students complete individual questions, and discuss their

working when finished. A separate example dialogue is given separately in Appendix VI.

On completion, Miss Clarke deletes the screen and begins loading the next. Rather than allowing social conversation though, this time Miss Clarke asks questions.

Miss Clarke: Where is everyone up to with their weekly work?

Belinda: I've nearly finished last weeks work.

Andrew: I'm just about to start last weeks' work.

Christopher: Me too.

Christopher is reluctant to comment further as there are a few students in the library near where his Telematics equipment is set up and when he speaks the other students turn around and stare.

Bill: Yes, well ...I'm a little behind actually.

Miss Clarke: Has anyone had any problems, or do you have any questions?

Silence.

Bill: No, I can do it. I just have to get organised.

Meanwhile the next screen has loaded and is waiting.

Miss Clarke: Belinda would you read the next screen?

Lesson continues in this manner until the hour is complete.

After the lesson

At the finish, all give polite words of goodbye.

Students and teacher disconnect their modems and the Telstra voice connection, take off their head phones and move off to their face-to-face class or to their study time or break.

As schools all operate on different times Belinda and Bill's recess has finished. Andrew has completely missed his recess as it started and finished while he was in his transmission. But the mainstream Year 9 mathematics lesson began straight after recess and before going to class, to do his study, he is allowed time for a break.

Christopher's recess is about to finish, he goes to find his friends before they have to go to class, and he has a little extra time before going to his next class. Miss Clarke has missed recess and has a few minutes for a glass of water before her face-to-face class begins.

Appendix V - Dialogue Example (Technology Problems)

Some background to the dialogue

Class 9-03 consisting of Jim, Jamee, Leslie and Kristine is used to provide an insight into a lesson in which there are a number of problems occurring.

Leslie, who lives in far North Western Australia has been experiencing electrical storms for the past week, he is dubious about connecting by telephone to his mathematics lesson. Leslie goes to the Telematics room, but is reluctant to turn on the computer or modem and only dials the 1800 number to connect to his teacher. He has been missing a few lessons and is becoming concerned he is falling behind in his work.

Kristine has been detained due to a school assembly, her Telematics coordinator informed her before hand she would have to miss part of her lesson, and Kristine facsimiled a notice to her mathematics teacher why she will be late.

Jim has been ill and had intended to dial the 1800 number from home and join in the class discussions. However, as the time for the lesson draws closer, he is not feeling particularly well and stays in bed.

Jamee arrives at the Telematics room, turns on the modem and computer and dials the 1800 number. When her computer has loaded, she has her computer dial the teacher's modem. Miss Clarke in the meantime has collected Kristine's facsimile and she dials the 1800 number.

This lesson takes place three-quarters of the way through the year and students and teacher are accustomed to a routine for connecting modems. It is important to note that if the lesson occurred earlier in the year, much more time would be used relaying such information and establishing this routine.

The lesson begins

Miss Clarke hears two beeps as both Jamee and Leslie connects to the voice-line.

Miss Clarke: Hello.

Jamee and Leslie: Hi Miss Clarke.

A screech is heard as Jamee's and Miss Clarke's modems try to connect.

Miss Clarke: Ahh, that doesn't sound very promising. Whose modem is that?

Jamee: That's mine.

Leslie: Um, Miss Clarke, sorry, but we've been having electrical storms and so I only came in to say there's one on right now and that I won't be staying.

Miss Clarke: Oh, okay Leslie. I will fax you what work we do this lesson; you had better hang up, and pull the phone and power lines out of the wall as well. We'll see you later in the week.

Leslie: Yeah, okay, bye.

A beep is heard as Leslie's telephone is disconnected from the conference call.

Miss Clarke: Okay, Jamee, what seems to be happening?

Jamee: I don't know, the modem's not connecting, should I try again?

Miss Clarke: Um, well, did you check your modem speed, I'm just checking mine.

Jamee: Yes, mine's on 14.4.

Miss Clarke: Yes, so is mine. Is the right type of modem been selected? Has anyone been in changing the setting?

Jamee: I'm just checking, no mines right.

Miss Clarke: Yes, mine's right as well. Okay, how about you try calling me once more and we will see.

Jamee: Okay. Oh, and Miss Clarke, Jim won't be here today he's sick, he said he might phone in from home.

Miss Clarke: Thankyou. Kristine is going to be late, she sent me a fax saying she has an assembly this morning. So it looks like it's just us this morning. While we're waiting for the modem, I have a few things .. [interrupted]

The screech of the modems trying to connect is heard again, conversation halts waiting for it to stop. However, it keeps screeching. Miss

Clarke goes into the modem menu and presses hang-up, the screeching stops.

Miss Clarke: Okay, I don't think that was going to work. How about I try to call you, if that doesn't work, we'll give up. Tell me when you're ready for me to dial.

Jamee: Yep, I'm ready.

Miss Clarke looks at the clock it's now passed 10 minutes into the lesson.

Miss Clarke: If this doesn't work, we'll just use our own screens and the disks, have you got your Interpreting Data disk there?

Jamee: Oh, no I don't. We don't leave them in here because people come in and take them, so Jim has that disk in his file.

The screech of the modems trying to connect is heard yet again, but it fails.

Miss Clarke: All right, let's try some pen and paper questions. Can you tell me ... [continues]

Miss Clarke leads Jamee through a number of questions and they discuss Jamee's answers, insights and queries. At about 30 minutes into the lesson, a beep is heard.

Miss Clarke: Hello?

Kristine: Hi Miss Clarke, sorry I'm late, did you get my fax?

Miss Clarke: Yes I did thank you. Jamee is here.

Kristine: Hi Jamee.

Jamee: Hi.

Miss Clarke: We were discussing some ideas. Do you want to see if you can connect your modem, Jamee and I didn't succeed before, but we could try.

Kristine: Yes, okay.

Miss Clarke: Kristine?

Kristine: Yes.

Miss Clarke: I can hardly hear you; you sound like you're on the other side of the room. Jamee can you hear Kristine.

Jamee: No not really.

Kristine: Is that better.

Miss Clarke: Yes, thank you.

Kristine: I don't know what's wrong with this mircophone, I'm leaning in right on top of it.

Miss Clarke: Oh, have you told your coordinator about it?

Kristine: Yes, we've got a new one coming.

Miss Clarke: Good. Well, while you are getting your modem organised Kristine, we'll continue with our discussion... [continues]

Miss Clarke continues her conversation with Jamee until Kristine has finished setting up her computer and is ready to give her attention to the lesson. Miss Clarke outlines for Kristine the lesson to date. A screech is heard as Kristine's modem connects.

Miss Clarke: Excellent. Jamee, how about we try to connect your modem again?

Jamee: Yeah.

When all three computers are connected Miss Clarke opens the file on disk and after a few minutes, the file appears on the computer screens of the two girls.

Miss Clarke: Kristine, could you read for us the notes on the screen.

Kristine: Yes. Discrete data are ... [continues]

Miss Clarke: Thankyou Kristine. Lets consider this problem. ... [continues]

A few minutes later Miss Clarke uses the mouse to demonstrate a point with the working for the example given on the screen.

Miss Clarke: So we can see this ... [demonstrates with mouse] ... here ... [continues]

Jamee: Um, my computer's just come up with a message

Kristine: Yes, my computer's just disconnected

Miss Clarke: Yes, my computer's just frozen, so don't do anything just yet, I'm just re-booting my computer and the modem shouldn't actually have disconnected. We'll see in a second.

Miss Clarke looks at the clock. It's seven minutes to the end of the lesson, and calculates it will take at least two or three minutes to re-boot the computer, then to get back into Electronic Classroom and then another one or two minutes to re-send the file.

Miss Clarke: Actually girls, it's probably no use. By the time I get this re-loaded it will be the end of the lesson. So you can have an early mark, unless anyone has any questions for me?

Silence as teacher waits for any responses.

Miss Clarke: Okay, well, I'll see you next lesson.

Jamee: Yeah, actually, ... [continues].

Appendix VI - Dialogue Example (Individual Questions)

Four questions, numbered one to four, appear on the computer screen.

Miss Clarke: If everyone can grab a piece of paper and pen, Belinda you try question 1, Bill 2, Christopher 3 and Andrew 4. When you're ready let me know and you can start writing your working on the screen. If you are stuck, tell me.

A general silence ensues as students take some time to attempt their own question. Miss Clarke uses this time to check her records of students completing their weekly work and any other outstanding work.

Christopher: Yep, I've finished.

Miss Clarke: Have you checked your solution?

Christopher: Oh no, I'll do that now.

Andrew: I have though.

Miss Clarke: Alright, are you ready to write your working on the screen, try to remember the setting out as you go.

Miss Clarke divides the screen into four sections using the drawing tools and passes control to Andrew who writes his working on the screen.

Bill: Can I do mine next?

Miss Clarke: Have you finished and checked it all?

Bill: Yes.

Miss Clarke: Okay, but Christopher was first.

Christopher: No actually, I've found a mistake. I'm just re-doing mine now.

Miss Clarke waits for Andrew to finish and then gives control to Bill.

Miss Clarke: How are you going Belinda?

Belinda: Yes I'm okay, I'm about to start checking my answer.

One by one, students write their solution on the screen.

Miss Clarke asks Andrew to explain his working as he explains his work the other students and the teacher follows the working given, comparing it for what they would have done and use either his/her calculator or mental estimating to check the calculations. Miss Clarke also makes comments on setting out. This process is repeated for each of the other students.